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ABSTRACT

The purpose of the forum was to establish an agenda for action, supporting steps that individuals, institutions, organizations, and governments can take together in working to reform and revitalize science and technology education at all levels. This report contains the comments of some 50 speakers and attempts to capture the essence of the wide range of ideas and suggestions discussed. Summaries of six Focus Area Group discussions address the following topics: (1) the nature of and the need for scientific and technological literacy for all; (2) scientific and technological literacy for development; (3) the teaching and learning environment; (4) teacher education and leadership; (5) assessment and evaluation; and (6) non-formal and informal development of scientific and technological literacy. Discussion is outlined for the following regional groups: Africa, Arab States, Asia and Pacific, Europe and North America, Latin America, and Small Island States. The Project 2000+ Declaration is included in the report. Appendices contain the Forum programme; opening addresses by Federico Mayor and M. Georges Laforest; plenary addresses by T. Odhiambo and Jacques-Yves Cousteau; a participants list; and a list of documents produced. (LZ)

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ED 383 555

International Forum on Scientific and Technological Literacy for All

Paris, 5-10 July 1993

Final Report

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Project 2000+

International Forum on Scientific and Technological Literacy for All

Paris, 5-10 July, 1993

Final Report

UNESCO

ED-93/Conf. 016/LD-14

In 1990, the World Conference on Education for All recognized the urgent need for 'a world community of scientifically and technologically literate citizens'.

Project 2000+ was initiated to promote and guide the implementation of the scientific and technological dimension of education for all.

Project 2000+ seeks to:

- identify ways of promoting the development of scientific and technological literacy for all;
- put forward educational programmes (formal and non-formal) which will empower all to satisfy their basic needs and be productive in an increasingly technological society;
- provide guidelines for continuous development of science and technology educators and leaders;
- encourage the formation of broadly based national task forces to initiate programmes for greater scientific and technological literacy;
- support the development of a wide range of projects designed to promote solidarity and co-operation in achieving scientific and technological literacy for all; and
- support the evaluation of existing and projected programmes in this vital area.

Project 2000+ is a joint venture based on a partnership between a group of major intergovernmental organizations and agencies, and non-governmental organizations with special concerns and responsibilities in the field of science and technology education and research. It is being carried out in three phases:

Phase 1 (1992 - July 1993): collection, analysis and collation of information; completion of surveys, pilot projects and preparations for Phases 2 and 3.

Phase 2 (July 1993): convening of the International Forum to discuss issues and develop guidelines for designing, implementing and evaluating projects in Phase 3

Phase 3 (July 1993 - 2001): a long-term co-operative effort to move forward on a broad front developing and strengthening interlocking links between United Nations and other intergovernmental agencies, governmental bodies, bilateral donors and non-governmental organizations. The basis for action - the Project 2000+ Declaration and its recommendation that by the year 2001 there should be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

PREFACE

The Project 2000+ International Forum on Scientific and Technological Literacy for All was a novel and successful collaborative venture. The Steering Committee for the Project comprises representatives of the World Bank, the United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF) and UNESCO as well as of the Commonwealth Secretariat and a number of non-governmental organizations, notably the International Council of Scientific Unions (ICSU) and the International Council of Associations for Science Education (ICASE). It was at their initiative that the Forum brought together the 400 participants from some 80 countries who enthusiastically demonstrated their commitment to the task of achieving scientific and technological literacy for the peoples of all nations.

The purpose of the Forum was to establish an agenda for action, supporting steps that individuals, institutions, organizations and governments can take together in working to reform and revitalize science and technology education at all levels. It provided a time for reflection on a number of serious issues, it constituted too a launching pad for action.

All this is reflected in the Project 2000+ Declaration which the participants adopted by consensus at the close of the meeting. This found its driving force in the World Declaration on Education for All and in the Rio Declaration. Calling on both governmental and non-governmental bodies world wide to work together to promote scientific and technological literacy for all, the Declaration throws out a challenge. We must quickly bring about through educational means of all kinds, formal and non-formal, a society which is enriched by a conscious sense of the scientific and technological dimension of its culture.

On behalf of Project 2000+ I invite every reader of this report to join in accepting its challenge in the spirit of international co-operation and solidarity. Let us work together to make a reality of scientific and technological literacy for all children, youth and adults throughout the world.

Colin N. Power
Chair
Project 2000+ Steering Committee

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PROJECT 2000+ FORUM

Co-chairpersons	Mr Colin Power Mr Bob Lepischak
Secretary/Coordinator	Mr Emmanuel Apea
Rapporteur-General	Mrs Sheila M. Haggis
Consultant to Project 2000+	Dr Jack Holbrook

PROJECT 2000+ STEERING COMMITTEE

United Nations Educational, Scientific and Cultural Organization (UNESCO)

The World Bank

United Nations Development Programme (UNDP)

United Nations Children's Fund (UNICEF)

Commonwealth Secretariat

International Council of Scientific Unions (ICSU)

International Council of Associations for Science Education (ICASE)

International Organization for Science and Technology Education (IOSTE)

Gender and Science and Technology (GASAT)

World Council of Associations for Technology Education (WOCATE)

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INTRODUCTION

The Project 2000+ International Forum was formally opened on Tuesday, 6 July 1993 by Mr Federico Mayor, Director-General of UNESCO, who welcomed the 400 participants. They had come from some eighty countries and among them were representatives of other United Nations Agencies and international governmental bodies as well as of a large number of non-governmental organizations.

Mr Mayor emphasized the need, through educational means of all kinds, to bring about a more thorough infusion of scientific and technological culture into society. The focus of Project 2000+ must be on coping with the world around us, on the need to face the challenges of change. The Forum, he said, would provide a unique opportunity to reflect on many issues related to scientific and technological literacy and to put forward suggestions for constructive action at the regional, sub-regional and national levels.

The opening session was also addressed by M. Georges Laforest, Chief Inspector of Education of the Ministry of Education (France), who welcomed participants on behalf of the Government and people of France. He drew attention to the considerable extension of the dimension of science and technology as integral components of culture, and to the impact this had on all aspects of political, social, moral and economic life in all countries. Science and technology education was not simply a matter of acquiring knowledge but also of acquiring attitudes and aptitudes that will enable the student of today to play a more effective role in shaping the choices that will determine tomorrow's society.

Following the opening plenary session, the work of the Forum continued in six Focus Area Groups:

The Nature of and the Need for Scientific and Technological Literacy

Scientific and Technological Literacy for Development

The Teaching and Learning Environment for Scientific and Technological Literacy

Teacher Education and Leadership for Scientific and Technological Literacy

Assessment and Evaluation for Scientific and Technological Literacy

Non-formal and Informal Development of Scientific and Technological Literacy

A second plenary session, on the morning of Thursday 8 July, was addressed by Prof. T. Odhiambo who spoke on the nature of scientific and technological literacy with particular reference to Africa, a continent whose people had always been intensely literate in oral tradition and in reading verbal and body language.

At a special public session, on the evening of Thursday, 8 July, participants were addressed by Captain Jacques-Yves Cousteau on the theme 'The Race between the School and the Cradle'.

Six Regional Groups (Africa, Arab States, Asia, Europe, Latin America, and Small Island States) convened on the afternoons of 7 and 8 July and on the morning of 9 July. They were invited to prepare suggestions for Phase 3 of Project 2000+.

The Project 2000+ Declaration, which was formally submitted to the closing plenary session on 10 July, is the product of a process of consensus building that helped to enrich the original draft text. In subscribing to the Declaration the members of the Forum implicitly accepted the responsibility of doing whatever they could in their respective spheres of activity to work to ensure that their words are translated into effective action.

This report, which is published by UNESCO on behalf of the Steering Committee for Project 2000+, is in fact the product of the efforts of some fifty rapporteurs to capture the essence of a very wide range of ideas and suggestions. The written word cannot adequately reflect the richness of the many stimulating and challenging discussions but it is hoped that it will, at least, constitute a useful 'aide-mémoire' for those who took part in the Forum and serve also to communicate to others a measure of their enthusiasm and commitment to the true intent of Project 2000+.

Exhibition and materials display

During the Forum a large exhibition area was placed at the disposal of both participants and suppliers of educational material and equipment.

Twenty-four exhibitors from a number of countries set up stands displaying and demonstrating various types of school science and technology teaching equipment and materials.

Among the participants, more than thirty groups and individuals brought with them posters, books, documents and many kinds of teaching materials which they displayed to illustrate and explain innovative science and technology projects and educational programmes in their respective countries and regions.

Facilities were also provided for the showing of videotapes relevant to the theme of the Forum.

Visit to the Cité des Sciences et de l'Industrie, La Villette

Special arrangements were made for participants in the Forum to visit this impressive centre for popularizing science and technology on the afternoon of Friday, 9 July. Opened in 1986 in a 35 hectare culture park, and financed by the French government, the Cité receives over 5 million visitors a year.

On the preceding evening, Madame Paule Ferran gave a short informative lecture, explaining the broad aims of the Cité, notably in the fields of education, training, the professions and research. Special emphasis was placed on an inter-active approach to both formal and informal education. She then outlined the programme of the visit which had been specially prepared for those attending the Forum.

Acronyms used in the main text

ALECSO	Arab League Educational, Cultural and Scientific Organization
GASAT	Gender and Science and Technology
ICASE	International Council of Associations for Science Education
ICSU	International Council of Scientific Unions
IOSTE	International Organization for Science and Technology Education
ISESCO	Islamic Educational, Scientific and Cultural Organization
OAS	Organization of American States
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
WOCATE	World Council of Associations for Technology Education

THE PLENARY SESSIONS

FIRST PLENARY SESSION

The First Plenary Session of the Forum took place on the morning of Tuesday, 6 July 1993. It was addressed by Mr Federico Mayor, Director-General of UNESCO, and by M. Georges Laforest, Chief Inspector of Education of the French Ministry of Education (see Appendix 2).

Speaking as Co-chairperson of the Forum and on behalf of the Project 2000+ Steering Committee, Mr Colin Power introduced the structure which had been planned for the Forum. At its centre were two series of working groups, one concerned with major themes and topics, the other with possibilities for action in the varying social and economic settings of different geographic regions.

Mr Power recalled that, recognizing the urgent need to create a world community of scientifically and technologically literate citizens, Project 2000+ had come into being as an international consortium of intergovernmental bodies and international non-governmental organizations. Its aim was to seek to mobilize support worldwide in concerted efforts to bring scientific and technological literacy within the reach of all, particularly youth, women and girls. Its driving force was to be found in the World Declaration on Education for All with its call for action to meet the basic learning needs of all children, youth and adults.

He went on to say that Project 2000+ had already carried out an extensive literature search on the subject of scientific and technological literacy. An important part of the task of the Forum would be to further clarify and elucidate the meaning of scientific and technological literacy on the basis of information which had been collected in bibliographies, review articles and other texts and documents and, where relevant, to draw attention to the existence of material not so far gathered. This process of clarification was not to be seen as an academic exercise but as one of building a launching pad for action.

He pointed out that the Forum offered a unique opportunity for international action-led reflection and discussion. Its discussions, which would take place mainly in working groups, should seek to reach consensus without resort to voting.

Firstly, he said, six Focus Area Groups would each study in depth a particular topic. Each would include four 'leaders', one of whom would chair the discussions. The leaders, some of whom had themselves prepared bibliographies, had been asked in advance to review the literature made available for their groups, based on published works and on contributions by participants. These groups were invited to prepare for the Forum short reports putting forward their suggestions and conclusions based on questions and issues which had been formulated, trends in the literature, research findings and the results of evaluation studies carried out in their areas of focus.

Following on the work of the Focus Area Groups, he noted that there would be meetings of six Regional Groups, based primarily on UN geographical regions but also including one Group for Small Island States. Their goal would be to put forward developmental/research oriented national programmes. These might cut across the focus areas and, for example, take the form of projects, to include components of curriculum development, resource development, teacher education and evaluation of the outcomes. The projects might be wide-ranging or concentrate on specific issues but common features should be:

a) national project proposals with developmental guidelines, time lines and evaluative support;
b) proposals which have regional consensus, indicating regional priorities;
c) guidelines for the creation, formulation and operation of national task forces;
d) regional training and planning programmes;
e) regional networks to be created or strengthened;
f) plans of action for each member of the group on returning home, with time lines; and
g) coordination plans within the region.

The outcomes of the discussions should be embodied in a short report from each group to be presented at the final plenary session of the Forum.

He concluded by noting that the real work of the Forum would begin when participants returned to their homes with ideas and motivation to start work at the national level. To help such initiatives, the Steering Committee of Project 2000+ had prepared suggestions for a declaration encouraging all those concerned and interested to work together in partnership. A preliminary draft text for such a declaration was available for discussion in the Focus Area Groups and any suggestions for modification presented in writing would be considered by the chairpersons of the Focus Area Groups who would constitute a drafting committee to propose a final text for adoption by consensus at the closing plenary session of the Forum.

Following this introduction, Dr Jack Holbrook presented the Forum programme and provided further information with regard to the working groups, the written and audiovisual materials available to them, the exhibition and the planned visit to the Cité des Sciences et de l'Industrie, La Villette.

In conclusion, Mr Power emphasized the important role played by non-governmental organizations in promoting science and technology education. He emphasized in particular the close working relationship between UNESCO and the five non-governmental organizations which, together with the intergovernmental agencies, formed the Steering Committee for Project 2000+. These were: ICASE, which, with its Executive Secretary Dr Holbrook, had played a leading role in planning and organizing the Forum. ICASE had been set up with support from UNESCO and was now celebrating its twentieth anniversary with a membership of over 100 associations of science teachers and institutes. ICSU/CTS, the committee of the International Council of Scientific Unions established to coordinate work in interdisciplinary fields of science education, was celebrating its twenty-fifth anniversary by launching a restructuring exercise to take better account of the need for capacity-building. IOSTE was already making preparations for its seventh international conference which would bring together specialists and practitioners involved in research and development in science and technology education. GASAT occupied a special position with its concern for equity in the provision of education for girls and women in the fields of science and technology. WOCATE, which was formally inaugurated at a conference held on the eve of the Forum, was establishing an international communications network among technology education associations and organizations directed to the sharing of innovative solutions to the challenges of technology education.

Mr Power said that UNESCO was indebted to its sister agencies of the United Nations system for their backing and support as well as to the Commonwealth Secretariat which had also provided funding for a number of participants.

Mr Emmanuel Apea, Forum Secretary/Coordinator, expressed his thanks for the support of all those who had worked so hard to make the Forum a reality.

SECOND PLENARY SESSION

The Second Plenary Session of the Forum took place on the morning of Thursday, 8 July 1993. It was addressed by Prof. T. Odhiambo, Director, International Centre of Insect Physiology and Ecology, Nairobi (see Appendix 3).

Following the address by Prof. Odhiambo and chaired by Mr Bob Lepischak, the session received reports from the six Focus Area Groups. These paved the way for the members of the Forum to continue their work, meeting in six Regional Groups.

SPECIAL PUBLIC SESSION

At a special public session on the evening of Thursday 8 July, participants were addressed by Captain Jacques-Yves Cousteau on the theme 'The Race between the School and the Cradle' (see Appendix 4).

THIRD PLENARY SESSION

The third and final Plenary Session of the Forum took place on the morning of Saturday, 10 July 1993 with Mr Colin Power in the chair.

The Rapporteur-General presented the draft report. She emphasised that it came before the Forum as a result of the collective efforts of some fifty rapporteurs who had worked in the different Focus Area Groups, Regional Groups and a number of subgroups. The result could be described as an exercise in the participatory democracy championed by Captain Cousteau. She also described the process of consensus-building leading to the preparation of the Project 2000+ Declaration. Meeting as a drafting committee, the chairpersons of the Focus Area Groups had considered suggestions and proposed amendments to the original draft, and these had served to enrich the text in a number of important ways.

The reports of the six Regional Groups, together with their conclusions and suggestions, were then presented to the Forum. Their texts and those of the Focus Area Groups form the second part of this report.

The Forum then turned to consideration of the Project 2000+ Declaration. Following a short discussion of the revised text, during which note was taken of suggestions and comments made by several participants, the Forum formally adopted the Declaration as its own by consensus.

Mr Power expressed the special thanks of UNESCO to its partners in planning and organizing the Forum: to the Steering Committee, especially to ICASE and its Executive Secretary, Dr Holbrook, to the Commonwealth Secretariat, particularly Dr Sam Bajah, and to the sister agencies of the United Nations for their backing and support. He also expressed warm thanks to his Co-chairperson, Mr Bob Lepischak, and to the Rapporteur-General, Mrs Sheila Haggis.

But above all, Mr Power said, thanks were due to those who had made the Forum a reality - the participants, the speakers, the group leaders, the staff at Cité des Sciences et de l'Industrie, La Villette, the exhibitors, the UNESCO secretariat staff, and finally, but by no means least, the team of volunteers whose help had been invaluable.

* * * * *

In his closing remarks as chairperson of the Steering Committee, Mr Power welcomed the commitment which the participants had expressed in subscribing to the Project 2000+ Declaration. Its message was addressed to Ministers of Education and to all others in positions of power and authority - science and technology education is critical for development and for closing the development gap. His remarks were also addressed to the participants themselves - 'We have worked hard to prepare a successful Forum, we must now work even harder in the follow up' and, in the words of Professor Peter Kelly, "We must maintain the momentum"'.

Two points should be made:

Where we have been:

There were the golden years of the 1960s and 1970s when governments and private agencies not only believed in science education but actively backed its development. The International Congress on Science and Technology Education and National Development, organized by UNESCO in 1981, bore witness to their generous support.

Where we are now:

The end of the Cold War brought with it great changes and the promise of a peace dividend but the world faced growing internal conflicts and tensions. Captain Cousteau had graphically drawn attention to the gravity of the social, economic and environmental threats to human survival. Millions, especially girls and women, are still denied access to science and technology education and thus to the knowledge and skills needed to raise the quality of their lives and of their families. Even those in primary schools in many Third World countries lack simple texts and basic materials and their teachers, insufficient in number, are often lacking in primary science training. Secondary science and technology are weak even in technologically advanced countries, and it was difficult to recruit and retain high quality teachers.

It was against this background that the messages of Project 2000+ assumed their importance. They were not the messages of doom. Project 2000+ could speak for the thousands of science and technology teachers who were doing an outstanding job in the face of many difficulties. It could tell their story and defend them against ill-informed politically and economically motivated attacks. The Forum had been made aware of some of the creative solutions the science and technology education community was employing in the face of adversity. Important efforts were being made, through formal and non-formal initiatives and programmes, through co-operative endeavour linking schools, and through industry and communities, to address real and urgent problems in rural villages, in mega-cities, in 'silicon valleys'.

Now the question arose:

Where are we going?

The support by UNESCO for Project 2000+ will be firm and continuing. It constitutes a major thrust of UNESCO's 1994-95 programme; it enjoys the enthusiastic support of many Member States of UNESCO who are concerned about the gap that exists between science and their citizens, and between them and other countries. The thrust must be for a major place for science and technology education in national education plans and national development projects, funded by governments and by intergovernmental organizations and agencies. In particular UNESCO has an important role to play in assisting the development and in promoting the influence of professional NGOs, especially science and technology teachers' associations - hence its ready support for ICASE when the idea of Project 2000+ was first suggested. The Project 2000+ Declaration and reports of the Forum will now be disseminated widely throughout the world by UNESCO and the other members of the Steering Committee. The papers and other material prepared by participants will also be made available to a wide audience.

In his conclusion, Mr Power said that it was now incumbent on the participants in the Forum to move forward. In subscribing to the Project 2000+ Declaration, the members of the Forum were accepting the challenge of setting to work on the establishment of task forces in their own countries. This was the essential counterpart of the efforts at the international level to form a grand alliance in support of science and technology education for all. 'The time has come to make good our commitments.'

* * * * *

On the proposal of Dr Jayshree Mehta, the participants expressed their warm thanks to the organizers of the Forum.

THE FOCUS AREA GROUPS

FOCUS AREA 1

THE NATURE OF AND NEED FOR SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL

Group leaders:

Prof. David Layton, Chairperson and Bibliography
Prof. Pierre C. Karenzi, Rapporteur
Prof. Michael Dyrenfurth
Dr Ved Goel, Review

The group began its work in plenary session by reviewing a number of issues derived from the Focus Area 1 Bibliography and Review. These issues had been selected because of their significance for an understanding of the nature and need for Scientific and Technological Literacy (STL) for All. Thereafter, members divided into four smaller groups to:

- consider whether the issues needed to be added to, and to set priorities;
- discuss specific issues and arrive at a position on them; and
- recommend actions needed in order to achieve a more widespread understanding of the nature of and need for *STL for ALL*.

1. Issues for resolution

As a preliminary it was acknowledged that the term 'scientific literacy' (SL) had a longer history and had been more thoroughly explored than 'technological literacy' (TL), the latter being unfamiliar and relatively unused in several countries. There was also some difficulty in translating the term 'literacy' into other languages, e.g. French, without loss of meaning. (The French 'culture' was suggested as possibly capturing much that was implied by 'literacy').

The initial list of issues, in no sense exhaustive, included the following:

- the relationship of SL and TL to the basic learning needs as outlined in the World Declaration on Education for All from the Jomtien Conference of 1990;
- the meanings which might be assigned to SL and TL in a context where basic education cannot be assumed as a possession of the majority of children and adults;

- the relationship of SL and TL to each other and the extent to which SL has meanings and a set of justifications distinctive from TL;
- the relationship of SL and TL to other science related and technology related 'literacies' identified in the literature e.g. environmental literacy, ecological literacy, computer literacy, mathematical literacy, biological literacy, engineering literacy, AIDS literacy;
- the extent to which it is useful and feasible to think in terms of general SL and/or TL for all, or whether SL and TL are better thought of as:
    - context-related (i.e., what counts as SL will depend on the context of the learner);
    - individualistic, rather than collectivist (i.e. even within a common context, the needs of individuals for SL/TL may vary);
    - an 'attainments continuum', possibly with identifiable levels (e.g. Levels of biological literacy has been proposed including nominal, functional, conceptual and procedural, and integral and contextual. TL has been described in terms of a continuum and also as a tiered set of competencies - receiver, user, maker/repairer, evaluator, etc.)
- the extent to which gender considerations especially, and equity considerations generally, have influenced, and need to influence further, the meaning of SL and TL;
- the categories in terms of which SL and TL might be described, identified and assessed; and
- the identity, claims and influence of diverse interest groups/voices presently advocating SL and/or TL for all.

Throughout the discussion of these and other issues the group attempted to keep in mind that it was considering SL and TL for *all*, where '*all*' meant not just school-aged children (whether in school or not), but others, both women and men, through all stages of adult life. Therefore formal **and** non-formal/informal provisions were implied, although consideration of their specific forms lay outside the terms of reference of the discussion.

2. Discussion Outcomes

The group noted a restricted but nonetheless important . interpretation of SL and TL -the ability to read and write scientific and technological prose and understand technical terms (e.g. the ability to read and act upon simple pamphlets produced by advisory services and publications such as farmers' magazines, health leaflets). The relationship between STL and basic education was close; the development of SL and TL depended on a sound foundation of basic education and could feed back to expand this fundamental learning. Indeed, in situations where basic education was lacking, SL and TL could be instrumental in establishing this foundation.

However, it was agreed the SL and TL had meanings which went well beyond this restricted interpretation. (It was emphasized that TL was not to be equated with technical and/or vocational education, although, as with SL, it may retain some technical and/or vocational aspects.)

The emerging view was that the activities of science and technology, although feeding off one another, symbiotically and synergistically, are nevertheless different in their purposes, if not in other ways. A full analysis of the two activities, and of their distinguishing features, lies outside the scope of this report, but one point can be made unequivocally, that technology is *not* 'merely applied science'. The flavour of the different intentions, of curiosity-driven understanding, on the one hand, and purposeful and effective intervention in the made world, on the other, is partially captured in the well-known saying that 'scientists know why their bridges fall down; technologists doesn't know why theirs stay up'. Another point emphasized was that there is no 'right answer' to a design and technology problem - merely a preferred solution from a range of possibilities reflective of value judgements and drawing upon knowledge bases additional to science.

These and related considerations led the group to consider SL and TL separately for the purpose of reviewing needs for them and teasing out meanings. Each was also seen as a distinctive educational outcome. It does not follow from this that the group was endorsing any particular curriculum model for the acquisition by learners of SL and TL. In many educational contexts it may be appropriate to provide separate but closely related provision; in other contexts some more unified programme of teaching and learning may be the best way forward. The important consideration in any such planning and implementation is that the unique features of SL and TL are kept clearly in mind.

Central to much of the discussion of meanings, especially of TL but also of SL, was the notion of 'empowering' students (some participants preferred 'enabling'). It was emphasized that provisions for SL and TL needed to be very different from those which have distinguished traditional, disciplinary science courses. Student distaste for and withdrawal from these courses was one reason given for this proposition; such courses were rarely seen by students as appropiate to their own agenda of concerns and priorities. The full ramifications of 'empowerment' were not explored because of shortage of time e.g. there was little discussion of SL and TL in relation to students' construction of their own sense of personal identity. But 'empowerment' for tackling practical problems in the material context was fully discussed and in relation to this the group noted a political dimension to SL and TL for All. The goal 'for all' suggests not only a redistribution of knowledge but also of power and the concept embodied in the title of the Forum was one of very great potency. Some even regarded it as a subversive concept in the sense that if *STL for ALL* is ever achieved it would mean radical changes in the goals and organization of scientific and technological research and development.

A particular aspect of 'empowerment' relates to girls and women. Their under-representation in science and technology is well-documented and a matter of great concern. It is important that the meanings of SL and TL which we adopt are those which help to counter gender biases incorporated in present-day representations of science and technology.

The review of the literature of SL and TL had made clear that the concept of 'literacy' was currently much in vogue; it was being applied to individual sciences (e.g. biological literacy) and mathematics (e.g. mathematical literacy), to the environment, ecology and computers, as well to more specific areas such as AIDS literacy and even laser literacy. The group did not find an opportunity to explore in any detail the relationship of all those literacies to SL and TL and a clearer mapping of this territory would be helpful. Unless care is taken, the multiplicity of literacies could be a source of confusion. Several are clearly sub-sets of the larger SL and TL. Others, such as environmental literacy, go beyond SL and TL in the sense that they draw on economic and sociocultural aspects of the environment and a clearer understanding of the contributory role of SL and TL is important.

In attempting to assign operational meanings to SL and TL some groups formulated statements such as:

- the capability to function with understanding and confidence, and at appropriate levels, in ways that bring about empowerment in the made world and in the world of scientific and technological ideas.

No participant was claiming to have 'defined' SL and TL by such formulations and it was recognized that they left many questions unanswered. However, they were useful for the discussions. There was agreement that the capability so described might be fostered by:

(i) the acquisition of a core of knowledge - facts, concepts, skills - which might be relatively culture dependent;
(ii) experience of and understanding of the ways in which scientists and technologists work e.g. how scientists make and validate their knowledge: the kinds of warrants which underpin their claims. (This aspect might be much less culture dependent that the above); and
(iii) an understanding of the cultures of the scientific and technological enterprises; their values, attitudes, assumptions; their organizational structures of control; and their limitations.

While all of these are necessary for the acquisition of some level of SL, it could be that (iii), which is the basis for people's trust in science and belief in the credibility of its practitioners, is a necessary prerequisite for (i), which has been the staple of much previous science education.

Confidence to confront scientific experts, acknowledging their special attainments but at the same time being able to ask searching questions of them, depends on having a sense of what the scientific enterprise is all about and of making transparent its sociopolitical organisation of practice and the nature of the artefacts, e.g. theories, it produces. Without this, people remain enslaved to 'experts' and are likely to reject science.

Similarly, there was recognition of the central role of values in technological activity. Failure to appreciate the nature of the values embedded in all technologies might be regarded as a hallmark [characteristic] of technological *illiteracy*. To be technologically literate one needs a core of knowledge and skills as well as experience of working as a technologist and some understanding of the processes involved. But this alone would be unlikely to engender the confidence to question the actions of 'experts'. Of all technologies it is possible to ask 'who benefits?', 'who loses?', 'what were the alternatives?', 'what is the social/environmental impact?', 'who pays?' and 'what if?'. Only if we have succeeded in making transparent the characteristics of technology as a community of practice are we likely to achieve *TL for All*.

Although the groups spent less time on discussion of the needs for SL and TL for all, a number of points are worth recording.

Firstly, in many contexts the drive for greater SL and TL is related to concerns about national economic competitiveness in world markets, economic development generally and reduction in economic dependence. The relationship between SL and TL in the general population and national economic growth/wealth creation is by no means straightforward and there is a danger that SL and TL will be overburdened with responsibilities they cannot discharge if the economic imperative is allowed to become dominant in the movement for *STL for ALL*. This is not to say that economic considerations are unimportant, merely that education alone, in whatever form, is insufficient to ensure national economic well-being. Both science and technology have a crucial role to play in the development of human resources such as multi-skilled adults with positive work values, willingness to learn new skills, and good communication and problem-solving abilities.

Besides *economic functionalists* who take a strongly instrumental view of education, other interest groups pressing the need for SL and TL include:

- *professional engineers/technologists/scientists* - sound foundations should be laid for future members of these professions and an appropriate image of science and technology should be projected to improve their standing in society;

- *sustainable developers* - SL and TL should empower people with the knowledge and skills, and especially the values, needed to undertake and control technological developments in order to achieve an acceptable quality of life not only for themselves, but also for succeeding generations;

- *girls and women* - SL and TL should enable girls and women to incorporate their own values in scientific and technological activities; they should be able to define technological challenges, and respond to these, on their own terms;

- *participatory democrats* - SL and TL are necessary to ensure that decisions are not made exclusively by a small technocratic elite; SL and TL are essential for the achievement and continuance of participatory democracy;

- *liberal educators* - because science and technology are unique and distinctive features of human activity, all children/people should have access to them as a right. The argument of the liberal educators is well-captured by Eisner: 'To become literate in a wide sense means more than to be able to read, write and cipher. It means being able to use a variety of forms of representation for conceptualising, expressing and recovering meaning'. Science and technology are two of the most powerful symbol systems created to represent our experiences of the world.

The social shaping of SL and TL by these and other interest groups poses a number of questions. There is the potential for conflict. Can this be resolved satisfactorily? For example, can a curriculum for SL and TL be devised which satisfies both economic functionalists and sustainable developers, to consider just two of the interest groups?

Secondly, there is the 'is/ought' question. Where do power and influence currently reside in relation to the social shaping of SL and TL? And, taking a longer view, where ought they to reside? The power of precedents and of contemporary concerns can be very strong and it is clear that, in many contexts, TL, in particular, is still trammelled [restricted] by its vocational origins and is having to respond to economic pressures in a period of severe recession. Yet considerations of social justice and quality of life alone suggest it would be irresponsible to future generations to allow SL and TL to have no concern for values other than economic ones.

Recommendations for Action

1. There is a need to develop more effective means of explaining the concepts of SL and TL, and indicate their importance.

2. The translation of SL and TL from the status of slogans to that of operational concepts which can shape the planning and implementation of educational programmes would be assisted by a rich supply of specific examples in particular contexts. These should be collected and widely disseminated.

3. Related to 2 above, we need good examples of the processes of adaptation of SL and TL to individual cultures and national needs.

4. Because TL is a more recent, and still not well understood, development, there should be support for the exchange of information and research into children's and adult's learning of technology comparable to the networks and mechanisms which already exist in the fields of science and mathematics.

5. It would be helpful to collect examples of SL and TL provisions which are reflective of concerns of particular interest groups. The issues of equity for minorities and gender balance are important here. Only when specific provisions are available for critical review will it be possible to ascertain the extent to which multiple interests in SL and TL can be served.

6. Debate should be encouraged among representatives of the various stakeholders [interest groups] in SL and TL with a view to reconciling positions and establishing common ground.

* * * *

The following note, which addresses the central role of the teacher in STL, also links with Focus Area 4:

Enhancing scientific and technological literacy: the need for systemic reform

Each country must determine the needs of its children, parents and communities, and decide the nature and extent of desired scientific and technological literacy, but there are some common elements to be considered:

Before we achieve educational reform, we must have instructional reform.

Teacher education

Reform in instruction is dependent upon the teacher who is, in turn, a product of teacher education and [teacher] environment. To enhance teaching, we must enhance both.

Teacher education should have as much status as any other educational programme. To do this, it should be taken seriously and have as much spent on it as on other science degree programmes. This would probably mean that teacher education programmes are in the most prestigious universities, not isolated in second class institutions.

Becoming a teacher requires that a person change certain behaviour. Such change requires time and intensive effort. As a result, teacher education programmes should be extended so that time is available for extensive and intensive intellectual and skill work in education. Perhaps students could complete a B.S. [B.Sc.] before beginning a two-year teacher education programme or have a five to six year B.S. [B.Sc.] programme.

Such extended time would allow teacher educators adequate time for modelling desired behaviours and strategies and revisiting topics needed. In addition, extended time would also allow for multiple practical experiences. For this to occur, however, teacher educators must be appropriately educated for specific roles. Complementing this would be teaching university science lecturers how to teach. And, to complete the cycle, teacher educators and teachers should be taught to conduct classroom research on a regular basis.

The university

Universities should change their curriculum and instruction to reflect the needs of prospective and in-service teachers. These needs include programmes of study which contain science courses and technology courses appropriate for teachers at a given level. Primary teachers, for example, need an activity-centred science and technology course.

Development of professionalism

If teachers are to be professionals, they must be educated and treated as such. To attain professional status, teachers need:

- an education befitting a professional. Such an education focuses on rationale, not just training in skills, the literature of the field, and a quest for new knowledge. Teachers must learn how to learn about teaching and to explain and discuss it as well as how to do it;
- time to meet and network with other teachers, both in school and in other settings;
- powerful and widespread science teacher associations;
- teacher centres for resources and support;
- continuing education which systematically enhances their teaching knowledge, skills and opportunity;
- freedom of time management and decision-making within the classroom;
- sabbaticals to work in industry and in further education.

Curriculum

Curriculum in a reformed education would allow for teacher and student decision-making and interest. Materials should include much that is teacher developed. The availability of local language and context should be used in all teaching materials.

Evaluation

Evaluation of students should be conducted as an integral part of the curriculum. In this sense, evaluation allows the student and teacher to know where they are and, perhaps, how to move on. Evaluation of teachers would be consistent with stated roles of teachers, not based on student outcomes directly. Teachers would be expected to assess their own achievements prior to any evaluation by others. All evaluation would be consistent with an established rationale for teaching.

Regulations

Rules governing education should be written with the needs of students, parents and community in mind. At the same time, they should allow teachers considerable flexibility in how to achieve curricular aims. Regulations should also enhance science learning by providing adequate time, resources and guidance to teachers. Regulations should assume teachers are professionals, not servants, by providing guidelines within which to work rather than agendas to be followed.

FOCUS AREA 2

SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR DEVELOPMENT

Group leaders:

Dr Michael Atchia, Chairperson and Bibliography
Dr Alicja Wojtyna-Jodko, Rapporteur
Prof. Hussein Daneshfar
Dr Joseph P. Stoltman, Review

In answer to the basic question of whether STL influences development, it was agreed by consensus that it does. The scientifically and technologically literate person is able to use the concepts, skills and values of science in making everyday decisions, and recognizes the limitations as well as the usefulness of technology in advancing human welfare.

The following subheadings were agreed upon, and the members of the group split into seven subgroups to consider them:

1. Clearer guidelines on STL for development
   chaired by Dr Joseph Stoltman
2. Programmes which develop links between goals of basic education and the teaching of science and technology
   chaired by Dr Leo Rebello
3. Strategies for more relevant teaching in science and technology education
   chaired by Prof. Peter Kelly
4. Relationships between formal and non-formal education in STL
   chaired by Dr Jan Harding
5. Curriculum development for STL
   chaired by Dr Sylvia Ware
6. New relevant resource material for STL
   chaired by Prof. K.D. Mayida
7. Popularization of science and technology among the general public.
   chaired by Dr J. Ben-Dak

As a result of the discussions, the following conclusions were formulated:

1. Guidelines on STL for Development: the imperatives:

the existence linkage between STL and development;

the future development of each country demands the application of STL skills at both basic and advanced levels;

basic STL skills will be developed by training in problem-solving and by applying these skills to real life problems, paying due attention to ethics, values and social dimensions;

STL depends upon a foundation of simplified, well-circulated materials about science and technology for the widest possible spectrum of society;

the development of STL is a continuous process associated with:
- individual or group motivation;
- determination of clearly defined goals;
- recognition of a wide range of resources across the spectrum of both formal and non-formal education.

2. Programme Links:

The basic goal of education is to prepare a citizen to play an active role in the democratic development of society.

The development of science and technology in society should be reflected in the scientific and technological literacy of the whole society.

Science and technology education should be open, innovative, field-oriented and integrated.

Science and technology education should come to people not only in the school but also in 'waiting time' (queues, hospitals, railway stations, bus stops) and other non-formal situations.

3. Strategies for More Relevant Teaching of Science and Technology -at primary level in countries where too few people are scientifically and technologically literate:

Choose topics relevant to fulfilling fundamental human needs (e.g. science and technology in the community, local environment).

Devise activities which will explain the environment and its relationship to pupils' lives, and enable them to communicate in a scientific way.

Produce appropriate infrastructures, e.g. a network of schools to exchange experiences in order to increase awareness of global problems.

Empower teachers to accomplish the above.

4. Relationships between Formal and Non-formal Education:

Many aspects of non-formal experiences are not supportive of science, e.g. advertising is often anti-science, science fiction can provoke horror, museums/science centres can be alienating (especially for girls and women), the media often present science in terms of extremes - the cause of all disasters or the basis of utopia.

How can better links be made between formal and non-formal science and technology learning?

Formal science/technology learning must be based on the learners' experiences and real contexts.

Non-formal experiences should bring out science and technology understanding.

For example:

- an extended visit to a model village may be more effective in educating adults in sustainable living than a formal adult education course;
- a technology centre (as in Lulea, Sweden) can be used to upgrade skills of primary teachers;
- the humanities/arts (dance, drama, fiction, including science fiction) can be used to challenge technologies and to teach science and technology;
- advertisements can be used as starting points;
- natural hazards, such as earthquakes, fires, can be used as starting points.

For sustainable and responsible development we can choose which technologies to use (although this may not be easy) but we must include basic science, which is essential for development.

Several problems remain:

- Formal curricula and schooling are often closed systems, leaving no access for non-formal links.
- External testing may create a strait-jacket.
- How can we achieve agreement on what basic science must be included?
- What assessment methods can best be used to measure achievement if our objective is STL for sustainable development?

5. Curriculum Development for STL

(a) Unless national policies support the development of scientific and technological literacy curricula, curriculum change is unlikely.

(b) Curriculum reform will not succeed if imposed from the top down. All stakeholders in the reform process must participate at some level; including teachers, principals, inspectors, educational administrators, parents and students, industry and organized labour.

(c) Science and technology should be taught as an integrated whole from the earliest grades into lower secondary school. A separate core plus options approach at the upper secondary level would broaden instruction for both the science and the non-science streams and provide an alternative approach to instruction at that level.

(d) There is no one science and technology content core which is appropriate for all countries. Each country has its own development needs to be addressed through the curriculum. However, the new 'science and technology for all' curricula do share common characteristics.

They:

- are based on perceived national needs (such as shelter, transport, energy, agriculture, health, development of resources, protection of the environment);
- are interdisciplinary;
- emphasize hands-on science and technology using local materials;
- are based on a utilitarian approach;
- view science and technology content not only as facts and concepts but also as **processes** of science and technology, inquiry and decision-making;
- include values and ethical considerations;
- reflect the way in which scientists actually do research.

(e) Teacher participation in the reform process facilitates the implementation of the new curricula. Continuing teacher in-service support as well as reform of teacher preparation are necessary if new content and new pedagogy are to be implemented successfully.

(f) Unless the assessment procedures and mechanisms support the curriculum effort it is unlikely to be implemented successfully. That which is not tested (including practical work and inquiry and decision-making skills) is not taught.

6. New Relevant Resource Material for STL

The group carefully avoided getting entangled in *definitions* but instead posed four questions to ensure that members interpreted the questions in the same way; the questions were centred on: what is it we want to teach, to whom, at what level, and in what environment?

The topics were rephrased as 'New approaches to local resource material for STL', with the word 'resources' interpreted as human, material and financial resources The group also considered the necessity for the material to be environment friendly.

After a lot of discussion about the realization of the goals of scientific and technological literacy for *all* by the year 2000+, the group decided to focus on possible solutions/recommendations for implementation by the majority of Third World countries. These guidelines were arrived at taking into consideration the socio-economic circumstances of these countries.

The group reached unanimity on the need for the establishment of resource centres and of 'networking' in partnership with industry: first for teachers and, at a later stage, for pupils.

A number of resource materials were highlighted:

- textbooks incorporating local examples;
- printed material and science kits;
- photocopies;
- electronic media: television, video films and radio
- computers and software packages;
- teachers' guides.

7. Popularization of Science and Technology (S & T) among the General Public.

(a) Objectives for well-organized popularization:

- that which is meaningful for the country's national goals, relevant to local needs and which carries easily comprehensible cultural interpretation;
- that which elicits motivation in new careers, access to STL also for women, and forecasts 'S & T-driven choices' which are concrete possibilities for individuals and groups;
- that which makes STL both enticing and accessible to all segments of society;
- that which shows means and options for local people to take charge of and use in their daily life;
- that which uses the family as a key catalyst.

(b) The key target group: the poor, distant and disfranchised (especially those not able to read and write)

means of significant promise:

- relate S & T to essentials such as food production, health and local needs;
- use multi-purpose centres as S & T popularization bases by associating communication and exploration with extension services and re-extension services;
- maximum use of long-lasting radio programmes with local material or re-interpretation of science in the local context;

- extension of use of videos and images of products;
- developing 'resource centres' which feature demonstration and quick response to local issues;

(c) The target group which must always be a prime audience for S & T popularization is from very early ages 3-4 through to 28.

means of significant promise:

- active learning, experimentation and probing exercises to make basic science and essential technology topics of 'total immersion';
- encouragement of reading and systematic exploration of technology;
- teachers and leaders to function as catalysts.

(d) Other target groups:

- the literate public who have yet to explore S & T;
- the source of a major potential for expanding STL : scientists and technology practitioners.

means of significant promise:

- accepting the role of coach, teacher, demonstrator, guide by S & T experts as a national and civic responsibility;
- preparation of books which answer (general] objectives as well as special needs booklets, monographs, posters and cartoons;
- clear and targeted S & T explanations of superstitiously held beliefs (local reference);
- any creative way to shock or tantalize people into considering S & T relevant.

FOCUS AREA 3

THE TEACHING AND LEARNING ENVIRONMENT

Group leaders:

Dr André Giordan, Chairperson
Dr Cristina Padolina, Rapporteur
Dr Maria Saez, Review
Dr Boyd Gunnell, Bibliography
Dr Kurt Riquarts

Three questions were addressed by the group:

Strategies:
To what extent do the following teaching and learning strategies satisfy the constructivist principles of learning: problem-solving; group discussion; exploring science; and project work?

Constraints:
What are the constraints and the critical features of these constraints which limit or prevent the implementation of these strategies?

Action:
What action should be taken to overcome these constraints and permit technological literacy?

1. Strategies

Problem-solving

This is a potentially valuable strategy because of the self-motivation which it engenders in the learner, particularly because it can easily be linked with real life situations. However, the attention of the learner may become so fixed on the goals that the process of problem-solving is not grasped. More classroom-based research on problem-solving is needed especially in evaluating the effectiveness of this strategy.

Group discussion

The value of group discussion lies in its ability to stimulate, motivate and challenge the learners, involving them in contributing to and participating more actively in the learning process, bringing forward alternative ideas, solutions and possibilities, improving the learners' questioning skills and ultimately increasing the likelihood of the students clarifying their conceptual understanding. The opportunity for maximizing learning is also promoted when group discussion follows experimental work. The ability of group discussion to foster constructivist learning depends on the given task - whether it is manageable for the teacher, interesting for the student, and conducted with an openness and tolerance of the ideas of others. There is a need to develop techniques for reporting the outcomes of the group discussions (poster reports is one possibility) as this is an important step if this strategy is to satisfy, for all students, the 'principles of constructivism'.

Exploring science

This strategy corresponds very well with the 'principles of constructivism' especially in its acknowledgement and consideration of the naive ideas, prior knowledge, personal history, and cultural background of the learner. This strategy, however, requires enough teacher knowledge to make the teacher confident to accept questions from students. It is also necessary for the teacher to have an understanding of the psychology of learning and how concepts evolve. The teacher should model the reflective and 'metacognitive' attitude towards knowledge construction. The teacher also needs to realize that learning takes time and the number of topics covered is not necessarily a measure of success. This strategy provides the students with good experience of science as a process, particularly if they are given the opportunity to pursue their own investigations.

Project work

This strategy provides the learner autonomy in the conduct of the activity as well as opportunities to construct concepts, processes, values and attitudes. The role of a teacher becomes that of a manager or organizer which requires a break from the traditional didactic model. This approach requires the teacher to carefully monitor learning to ensure that it remains focused on the intended learning objectives.

Although only four strategies were discussed there are others, such as concept mapping, predict-observe-explain (POE), which also adhere to the 'principles of constructivism'. Some of these may, in fact, be easier for teachers to adopt especially for large classes. In addition, although the strategies were discussed separately this does not suggest that they are mutually exclusive. The integration of two or more strategies for a particular task is likely, and often desirable. For example, problem-solving often includes group discussion.

2. Constraints

On research

A wider application of research findings in the classroom has not been realized because of the teachers' limited access to them. This may be due to the lack of awareness of teachers about these research results, or to the teachers' difficulty in understanding these findings and interpreting them for practical classroom use.

On the teacher

To utilize research findings in the classroom, the teacher must have the confidence to try new ideas and to have the freedom and time to direct and design teaching strategies. . Research is accumulating which suggests that teaching styles, classroom climates and modes of assessment in science and technology may contain gender biases which generally disadvantage girls. It is essential for teachers and decision-makers to become familiar with this research and the suggestions for action associated with it, if girls are to achieve equity in science and technology.

On the curriculum

The content of the curriculum is often made inflexible by regulation. The large number of topics to be covered may also result from prescription, although this may also arise from teachers' decision. There is a need for more cohesion between teaching, learning and assessment and for a 'holistic approach' to the assessment of the teaching-learning process.

On communication

Constraints may also arise from: differences in the language used in the school and at home; difference between common language and scientific and technological language; differences in the use and meaning of words among the sciences and different areas of technology. There may also be a need for improved dissemination and sharing of innovation between and among administrators, researchers and teachers.

On the learner

Greater involvement of the learner in the learning process is central to 'the constructivist model of learning'.

3. Action

The following principles ought to guide the planning and creation of a teaching and learning environment for STL:

collaboration is essential among individuals and institutions which have a stake in the education of everyone;

the principles of the 'constructivist model of learning' should be considered whilst evaluating and developing effective teaching and learning strategies for enabling STL;

the teacher plays a vital role in achieving *STL for ALL*;

the teaching and learning environment goes beyond the classroom and includes the surrounding natural environment where learning takes place, the political, social and cultural milieu, the curriculum and the teaching and learning strategies and resources.

The recommended action calls for the creation and maintenance of a network of communication and action to bring together all parties concerned in the education process. The efforts would be: (i) initiated by the identification of the knowledge, skills, values and attitudes needed by all to function productively in an increasingly technological society; (ii) advanced by a 'shift in paradigm' on how humans learn and understand and the formulation of appropriate strategies to enable learning; (iii) realized and sustained by the allocation of human and financial resources needed to establish the environment for the achievement of STL.

It is important to empower the teachers to initiate and become actively involved in the development of curricula and teaching and learning strategies. This will involve making research findings and procedures accessible to them through collaborative activity with researchers and science and technology educators. This learning and its dissemination will be complemented by providing them with opportunities to exchange and share ideas and experiences with fellow teachers, including both the more experienced and the less experienced.

Some specific recommendations and examples for action are:

- the introduction and understanding of a technological activity as a means through which scientific literacy is developed and technological capability is promoted;
- the establishment of grass-roots research and curriculum development;
- the promotion of STL through case-studies.

FOCUS AREA 4

TEACHER EDUCATION AND LEADERSHIP

Group leaders:

Dr Kevin Morgan, Chairperson and Review
Dr Myriam Krasilchik, Rapporteur
Dr Lucy Steward, Bibliography
Prof. Peter Okebukola
with particular assistance from
Dr Ron Bonnstetter and Ms Sonia Spencer

Two main comments arose from consideration of the relationship between technology and science in the context of teacher education and leadership:

Science and technology education should benefit from each other. Teachers need to be trained to appreciate and recognize that both areas exist independently but the sets overlap. Both have degrees of independence, but also have the potential to complement each other.

At the primary level, the teacher should have a good understanding of both science and technology, while at the secondary level there may be the need for specialization. However, even with specialization, a degree of articulation within the education programmes should be encouraged.

The most important issues relating to the preparation of technology and science teachers for the twenty-first century were also the subject of prolonged discussion, which led to the expression of a series of significant concerns, notably the degree or extent to which:

- teacher education programmes match the needs of the community in which the teachers are likely to be employed;
- the profile of the graduate matches the needs at the different levels of the education system;
- teacher education programmes include a technology education component;
- teacher education approaches are wide-ranging and able to cater for individual needs;
- problem-solving approaches are utilized;
- the quality of students entering teacher education programmes is adequate;

- teachers are empowered by being encouraged to develop as thinkers, visionaries, researchers, learners and inventors of new strategies;
- links with the broader community, including industry and commerce are encouraged;
- political agendas [considerations should not] override the structure and implementation of educational programmes, and hence reduce their effectiveness;
- teacher educators maintain currency in [keep up their standard of skills in] the [teaching] profession, and are credible in the teacher education environment;
- academia [universities] adequately rewards teacher educators for those activities which are related to maintenance of their continued involvement with teaching as a dynamic profession;
- models of instruction received throughout higher education courses may be incongruent [inconsistent] with good teaching practice and hence militate against good performance by the prospective teacher;
- teaching practice experiences are integrated into the teacher education programme, and the extent to which the school climate may be an obstacle to good teaching practice;
- programmes have involvement in supporting graduates in the early years of teaching;
- teacher education programmes, in science and technology, are adequately resourced;
- teacher education programmes demonstrate commitment to the principles of equity, both in their educational goals, and in their functioning;
- leadership development is implemented to effect change in education and helps reflection on practice.

The participants then divided into the four subgroups: Context, Models, Research, and Support. Drawing upon the issues raised in the first working session, they considered the principles which were common across all nations with respect to science and technology teacher education. The outcomes of their deliberations are summarized as follows:

1. Context

This group considered the issues of social and individual needs, and proposed that teacher education should prepare teachers who will:

- help bridge the widening gap between the general community and science and technology;
- promote scientific and technological literacy to enhance the quality of life in the context of individual freedom, responsible management of the environment and sustainable development;
- facilitate the promotion of science and technology related to the enhancement of the quality of daily life, the support for preparation for occupations, and the long-term benefit of the community;
- inform government, its agencies, industry, commerce and the community of the complexities of the teaching profession for its role in developing a scientific and technologically literate society.

2. Models

Regarding pre-service science and technology teacher education there should be:

- integration of subject content and teaching method;
- consideration of the local context and research findings, while allowing the graduate to adapt to different educational systems;
- the generation of an enthusiastic graduate who is committed to the profession;
- the modelling of good practice;
- consideration of the unique nature of technology.

Regarding in-service science and technology teacher education, it should be recognized as a matter of principle that:

- a wider group of people should be involved;
- the needs of the community should be a major consideration;
- a support system should be put in place to provide structures, leadership, networks and resources;
- those delivering in-service education (INSET) should be exemplary teachers and good communicators;
- teachers should be encouraged to reflect on their own practice and be flexible in their approaches;
- technical support staff should be provided;
- alternative models of learning should be explored;
- it is unlikely that every institution will be delivering all that is required.

3. Research

This subgroup which considered the issue of research in science and technology teacher education raised the following points:

- there is a need to recognize the diverse population of researchers in education;
- research may serve widely differing purposes;
- research should inform good teaching practice;
- research should influence decision-making in science and technology education policy and administration;
- the contextual limitations of research need to be recognized;
- teachers should be encouraged to be involved in action-research to produce improvements in teaching and encourage them to become reflective practitioners;
- there is need for better communication between those involved in research in schools and research institutions;
- there should be a feedback loop so that the teachers can learn from the outcomes of the research to improve their practice;
- many aspects of the new focus and challenge for scientific and technological literacy could be enriched by appropriate classroom-based action research with teachers and students.

4. Support

The subgroup deliberated upon the issue of support in science and technology teacher education and it was considered that support should:

- be a career-long process for teachers;
- involve partnerships from the world of production and the community; these partnerships would allow teachers to be exposed to the latest technology and also bring about commitment to science and technology teacher preparation programmes;
- be provided to update appropriate teaching/learning instructional materials, facilities and equipment;
- be provided to update teaching skills, knowledge of learners and content;
- include induction programmes to be put in place as part of the support system for beginning teachers;
- include salary structures attractive enough to recruit and retain the best teachers;
- include assistance to develop leadership to improve science and technology education.

Strategies and Proposals for Future Actions

1. Context

Programmes should:

- take into account diverse situations at local, national and regional levels;
- be locally grown and be contextualized within [appropiate to] the community;
- include work experience in classroom and in technical fields;
- include distance learning and provide adequate practical experience;
- include 'hands-on' activities which produce desirable attitudes towards science and technology;
- pay attention to values and attitudes, and critical appraisal of advertisements and the media;
- include strategies to bridge gaps between previous experience and new technologies;
- encourage student teachers to contribute their own experience in the learning process;
- be developed through a 'multisectoral' approach.

Incentives are required to attract and maintain a core of qualified teachers for science and technology. These incentives can include financial rewards, career advancement, improved resources and working conditions. Promotion procedures should take into account the quality of the teacher. Teachers should be given the opportunity to take teacher education courses in their free time.

2. Models

- Models/strategies may be different for primary schools and secondary levels.
- Programmes must have a balance between content and process.
- At the secondary level there should be specialists in technology education and in science education.
- Experienced teachers in schools can help in teacher education activities.

3. Research

Three types of research were identified:

- small scale
  local, low cost, limited dissemination, leads to change;
- medium scale
  possibly local, by academics, some cost, may lead to change;
- large scale
  national, theoretically oriented, expensive, may lead to eventual change.

Science and technology educators have a role to play in the different types of research, in interpreting and disseminating findings, to inform practice. UNESCO has a key role to play in coordinating comparative research activities.

4. Support

The support systems for teacher education include linkages with:

- the university - for flexible programmes;
- the community - for attachments and experiences;
- the employing authority - for professional development;
- the school - for tutors, action-research, support teams;
- the government - for resources.

Proposed Projects:

1. Development of distance teacher education programmes.
2. Development of emergency courses for teachers.
3. Provision of scholarships for teacher educators and teachers.
4. Long-term and longitudinal research on issues affecting the education of science and technology teachers and those in leadership positions;
5. Expansion of the research community.
6. Research in science and technology curriculum in countries.
7. Development and strengthening of low-cost equipment projects.
8. Research in 'constructivism' and strategies that teachers can use to help students learn.
9. Development of strategies, including leadership education, to educate sections of the public who are disadvantaged with respect to science and technology.
10. Establishment of links between schools and universities, and between school and home/community, to achieve the goals of scientific and technological literacy.
11. Evaluation of specific needs of teachers for scientific and technological literacy.
12. Provision of print and non-print support materials for teachers of science and technology.
13. Provision of flexible teacher education programmes for science and technology.
14. Research into the international implementation of technology education.
15. Research into equity issues in science education and technology education.

FOCUS AREA 5

ASSESSMENT AND EVALUATION

Group leaders:

Prof. Glen Aikenhead, Chairperson
Dr Pisarn Soydhurum, Rapporteur
Dr Tae Ryu, Review
Dr Medhat El-Nemr, Bibliography

Assessment and evaluation, in their many forms, must be part of any process of education because they provide essential vital feedback as to the extent to which the aims of scientific and technological literacy are actually being achieved. STL is essential for every citizen in a modern democratic society to participate actively and meaningfully in the various decision-making events and, therefore, assessment and evaluation are essential to guide pedagogically corrective measures in the education of a citizen to be literate in science and technology.

The process of assessment and evaluation does not produce a 'correct' conclusion, but rather one of many possible conclusions. We must accept this fact and other inherent limitations.

1. Requirements

- Assessment and evaluation must be an integral part of the teaching/learning event. It must be formative and not summative - an add-on at the end. It must be consistent with all goals, priorities, and the context of the course.

- Assessment and evaluation should improve the quality of the teaching materials and methods of instruction. Students' views, rather than just the 'correct' response, should be given more attention.

- Scientific and technological literacy must be operationally defined by good assessment and evaluation practices, and these practices must be widely disseminated in all education jurisdictions.

- Knowledge, skills (including higher-order cognitive skills) and values to be assessed should be embedded in an everyday setting relevant to and appropriate to the students. One such context is the mass media, which should be made use of in assessing and evaluating students' scientific and technological literacy.

- New curriculum projects must build into the lessons an appropriately wide range of assessment and evaluation methods, indicating what students can do in a variety of contexts. Traditional formats must be expanded.

- Assessment and evaluation should focus on a students' actual behaviour, ethics and values, using the evidence of their everyday experiences [actual behaviour].

- Validity and reliability should be redefined to correspond to a new conception of assessment and evaluation for scientific and technological literacy.

- The element of assessment, which is an implicit part of teaching based on 'constructivist' learning, must be made explicit. Steps must also be taken to improve reliability, for example, by moderation procedures, and by providing examples of students' actions and responses which have been assessed.

- Assessment modes may contain a gender bias. It is important for teachers and those responsible for generating assessment instruments to be aware of such gender effects and seek to avoid unnecessary bias.

- There should be assessment and evaluation of the capabilities of teachers to assess students in both formative and summative ways, as well as of the quality of instructional resource materials for STL.

- Assessment and evaluation methods appropriate for schools must also be used in programmes which train future teachers of science and technology. Pre-service students must experience during their training the methods which they will be expected to use in their teaching.

2. Research and Development

- There is a need to develop a complex database for scholars, teachers and organizations around the world. The 'World Assessment and Evaluation Database' would be a pool of files containing information covering a combination of items or activities such as teaching situations and assessment strategies, plus exemplars of strategies such as concept mapping, simulations, take-home exams, checklists, portfolios, journals, etc. The purpose of this international database would not be to dictate to countries about what should be assessed, but rather it would be to inspire regions to develop their own assessment and evaluation databases by translating, transposing and creating elements of a their own database.

  Data from these regional databases would be widely disseminated. Databases on scientific and technological literacy should acknowledge two purposes: assessing 'global village' knowledge pertinent to national policy, and assessing knowledge for feedback to students and teachers.

- Research and development is needed to bridge the gap between qualitative and quantitative assessment and evaluation, and to explore the relationship between students and teachers in science and technology learning for the purpose of gaining a better understanding of the development of students' learning of science and technology.

- Exemplar projects which use new methods of assessment and evaluation should be identified, e.g. the Dutch physics curriculum development and research project (PLON) and the Italian project on energy; an international team should be assembled to develop further methods.

- Research on the effect of the media on scientific and technological literacy should be reviewed and needed areas of research identified in order to improve understanding of the impact of the media.

- New methods in assessment and evaluation need to be developed for this out-of-school context and thus for the goal of lifelong learning.

- Assessment and evaluation methods should be developed for the skills of acquiring information, organizing information, and using that information;

- Because assessment and evaluation have traditionally focused on psychological aspects of learning, and because STL relates also to group activity by citizens, new methods of assessment and evaluation should be developed within a sociological perspective on learning;

- Common procedures, but separate instruments, for assessing both scientific and technological literacy should be developed, so that scientific literacy is identified separately from technological literacy, even though these both may be developed through the same activities;

- Given that science and technology represent two different ways of knowing about the same world, research should be initiated to find ways of integrating the assessment of science outcomes with the assessment of technology outcomes.

FOCUS AREA 6

NON-FORMAL AND INFORMAL DEVELOPMENT OF SCIENTIFIC AND TECHNOLOGICAL LITERACY

Group leaders

Dr Jayshree Mehta, Chairperson and Review
Dr Cheng Donghong, Rapporteur
Mr Brenton Honeyman
Dr James Bradburne, Bibliography

In the last two decades, an exciting change has happened within science and technology education - the development of non-formal and informal approaches to scientific and technological literacy. The global problems of the present era have changed the nature of the need for scientific and technological literacy generally. Considering, moreover, that one in five men and one in three women are illiterate and that 30 to 50 per cent of the children in developing countries are outside the formal education system, non-formal and informal education have an important role to play in developing scientific and technological literacy for all in the coming century.

1. 'Vehicles'

If we are committed to *STL for ALL* as a desirable destination, four broad means, or 'vehicles', for reaching it can be defined.

(a) *Out-of-school science and technology activities*

Science and technology clubs, camps, fairs, olympiads, symposia and competitions are all greatly enjoyed and appreciated by adolescents. The advantages of out-of-school programmes are several:

- practice: the opportunity to *do* science and technology;
- complex: science is seen as an integrated whole;
- opportunities: greater opportunities for doing and learning science and technology;
- methodology: science and technology as processes, not only as products;
- community: ability to respond to local circumstances and needs.

A number of recommendations were made:

- there should be training for those developing out-of-school programmes;
- all available means and networks should be used to carry out-of-school programmes;
- the private sectors should be asked to support non-formal initiatives;
- attention should be paid to the needs and influence of parents and communities in developing out-of-school programmes;
- an international symposium should be held to share information on out-of-school programmes and create new resource materials for sharing and distribution at all levels.

(b) *Mass media (television, radio, print)*

The mass media are an informal 'vehicle' with enormous geographical 'reach' and wide acceptance by its 'passengers'. A huge number of articles, books, video programmes and films on the popularization of science and technology have been developed in recent years. This material treats not only basic science, but has made available information on developments in high technology and the pure sciences to audiences as diverse as children, women, the general public and professionals. Several issues relating to the mass media and their role in developing scientific literacy for all were identified:

- in competing for limited funds, the media may not be perceived to be as important as formal education programmes;
- educators often prefer to use more traditional approaches;
- programmes need to be more interactive and participatory;
- stereotyped roles of women and girls, and of scientists, need to be avoided in order to promote science and technology for all;
- the import of foreign programmes set in foreign contexts, no matter how well-produced, may reinforce the impression that 'science' is not relevant to local culture;
- presenters and writers need to be expert communicators backed by experts in science and technology education;
- when the media are controlled by government or commercial interests, there can be difficulties in realizing open debate on science-related issues, or in avoiding pressures to respond to market-driven motives;
- planning and co-ordination, with clearly understood strategies, are urgently needed.

It was recognized that whether media programmes are produced to support formal education, or as a vehicle for non-formal or informal education, the educational principles are essentially the same.

(c) *Institutions of informal science and technology: science and technology museums and centres*

This is the fastest developing part of the non-formal and informal science and technology education sector. In it one can clearly see a major shift away from the static 'don't touch' exhibitions of artifacts towards exhibits which are participatory, 'hands-on' and interactive. Some science and technology centres have placed great importance on forging new links with their local communities and regions; initiatives which show the dawn of a new approach to science and technology education in these institutions, and the seeds of regional science networks. Several issues were raised in discussion of the strengths and weaknesses of the institutions of informal science and technology:

- partner or censor: the role of industry in the science and technology centre;
- facts or processes: what is the real nature of the science and technology we communicate?;
- encouragement of debate about science and technology: a new role for the centre;
- education or entertainment: the many reasons people visit science and technology centres.

Following the above discussions several initiatives were proposed. Science and technology centres should:

- put science and technology in context;
- be places of debate about issues in science and technology;
- recognize the skills and knowledge the visitor brings to the museum or centre;
- give the visitor the means to engage in a real debate, and also make each of the 'actors' visible: the scientist, the technologist, the citizen, the museum, industry, etc.;
- be models for innovation in formal science and in technology;
- be laboratories for change;
- present science and technology as they are practised, as well as the facts of science and technology;
- themselves reflect the openness of scientific inquiry;
- encourage initiatives which aim at reaching people who never come to science and technology centres, even if this means going beyond the traditional limits of these centres.

(d) *Community-based programmes*

To take into account the varying needs of people living in different communities is one of the most important strategies in developing scientific and technological literacy for all, and the key strength of the informal sector. In particular, successful programmes in rural areas for women and girls on literacy, maternal health care and hygiene deserve special recognition, as do programmes in applied technical training in many developing countries. Community programmes are particularly effective and appropriate where the community values, traditional experience and concern for the local environment are strong concerns.

Guidelines for community-based programmes include:
- recognizing and supporting local initiatives;
- coordinating local programmes into regional networks;
- promoting lifelong learning involving interaction and two-way communication;
- respecting people and their right to be independent and treated equally;
- using methods and activities appropriate to the local culture.

2. 'Passengers'

The target for all efforts to increase scientific and technological literacy is the people. With this in mind, the second session of Focus Area 6 was devoted to discussion of the 'passengers' being carried along in the 'vehicles' of informal education, as discussed in the first session. Two groups were looked at in some detail: the so-called 'general public', and women and girls.

(a) *The general public*

The importance of the general public as an audience was discussed under several headings, and several issues and opportunities were raised:

The importance of working with adults

- Children in school still have a chance to learn without special provision - adults may have lost that opportunity.
- Adult retraining and provision of new skills is an important role for the informal sector, e.g. for the unemployed.
- There are opportunities for linking formal and informal programmes.
- Adults in their role as parents can be encouraged to work with their children, which in turn strengthens the family unit and adds to the effectiveness of informal scientific and technological education.

The opportunities of non-formal programmes include:

- using adults in advisory, non-teaching roles (i.e. grandparents and parents helping the young in the extended family);
- developing collaborative working methods;
- encouraging discussion, mediation and resolution of conflicting views on controversial issues;
- emphasizing socially relevant and culturally appropriate topics;
- encouraging teachers to adopt less didactic, 'top-down' roles.
- 'making a bridge between the blackboard and reality';
- imparting knowledge which contributes to a better quality of life.

What do governments and sponsors stand to gain from non-formal education?

- The recognition of science and technology as an integral part of culture.
- Increased numbers of young people choosing to pursue careers in science and technology.
- More informed attitudes towards science, technology and the environment.

What activities should be encouraged under the umbrella of informal science and technology?

- science and technology centres, clubs, networks, and events (theatre, fairs, shows, workshops)

- national parks and wilderness areas
- opportunities for children to do real research
- laboratory/industry visits

(b) Women and girls

It is generally recognized that addressing the needs of women and girls for scientific and technological education pays large dividends throughout the entire community. The discussion in this group dealt with the following issues:

Motivation

- What motivates women for literacy programmes is often the socio-economic benefit they gain.
- Non-formal and informal programmes should show the practical benefits from acquiring scientific and technological knowledge.

Recognizing existing knowledge

- Scientific and technological literacy must be included in general literacy programmes because science and technology are a part of culture in its broadest sense.
- Women's existing scientific and technological competence in subjects such as agriculture, chemistry, medicine, must be recognized and built on, instead of attempting to replace their knowledge with standard forms.

Reaching women and girls

- Go to places frequented by women: the market, day care centres, community meetings.
- Speak directly to women in groups.
- Show practical examples.
- Recognize the need also to convince men because male conservatism can represent a serious obstacle to women's learning about science and technology.

1. 'Drivers and Directions'

(a) *Issues in informal and non-formal science and technology education*

Given its enormous potential to contribute significantly to scientific and technological literacy for all due to the number of people not touched by the formal education system, it was considered an important task to look at the specific character of informal science and technology education, at the characteristics which make it different from the formal education system, and to formulate a series of clear guidelines for new initiatives. These guidelines are of course influenced in large measure by the range of opinions about several key issues.

These issues include:

The relationship between the formal and informal sectors

Informal science and technology activities should be considered not only as an extension of the classroom, but should also be useful to the formal education system. Some contend that the formal and informal systems share the same goals, differing only in methods. Others place formal and informal education at opposite ends of a spectrum wherein informal education has as its goal the empowerment of the powerless, while the formal system aims at maintaining the status quo. Still others see the two systems as having different, though complementary functions, aimed at creating citizens able to participate fully in their society. The role of informal science and technology education is not solely to provide experience the schools cannot, but a different quality of experience. In so far as participation in informal science and technology is *voluntary*, and plays a broader role in society in encouraging and developing scientific and technological literacy, it contributes to the ways in which people become more effective social participants.

The nature of science

During the last decades, the perception of science has changed from being an agent for universal good to being an agent of destructive and unwanted change. This means that the moral, social and political dimension of science is assuming greater importance in informal science programmes. This change is reflected in the concern that science be presented as a process open to question and challenge, rather than a discrete series of facts. A science centre, for instance, which only gives facts about science risks is 'sinning by omission' in not providing the visitors with enough information about non-scientific factors such as politics, economics and culture, needed to understand scientific issues which affect their lives. It is not acceptable that informal science only treats science within the narrow confines of scientific principles and 'pure' science.

The role of political debate in the science centre

An essential complement to science as a process is the debate about science, and about issues in which scientific understanding plays a role. The questioning that is central to the practice of science, is also central to debate about science, and hence has a major role in informal science. This debate should be acknowledged and encouraged by making visible multiple points of view. The context in which science finds itself cannot be separated from the science itself, and one of the key roles of informal science is to contextualize science by linking it to the issues of everyday life. The science centre in particular can play an important role in providing a neutral environment in which debate about science and scientific issues can occur.

Points of agreement

The remarkable consensus achieved by the participants in Focus Area 6 should not mask the fact that the positions taken by the group represent a challenge to traditional thinking in the informal science and technology education community, and in themselves are an indication of the willingness on the part of members of the Forum to take risks and innovate. An example of the innovative nature of the Focus Area's commitment can be seen in its repeated insistence on the importance of placing science in context: something that only very few science centres have attempted to do consistently. The vast majority of science museums and science centres insist on demonstrating the principles of pure science, in particular, physics, optics and mechanics.

Points of agreement included the following:

- science and technology cannot be dissociated from the broader culture;
- social, political and economic contexts should be made evident;
- informal science is not necessarily school science;
- non-traditional and non-standard science and technology of indigenous cultures have their value;
- science is not limited to the natural and pure sciences.

From the work of Focus Area 6 the following guiding principles can be identified, and should be considered criteria for future projects and programmes in informal science:

(b) *Principles for action*

Science and technology must be put into a broader social and cultural context : equally, the value of local culture, traditions and concerns must be recognized. By recognizing the value of culture to science and technology, and their value to culture, informal science and technology contribute to motivating people to understand and value science and technology in their lives.

Issues are central to understanding: most people do not experience science and technology in isolation but as part of broader social issues: pollution, environmental protection population growth, hygiene, health care, etc. Issues are central to the understanding of science in context and should be used as a basis for developing non-formal and informal programmes. These issues cannot be restricted to the natural sciences alone, but must encompass the full range of social sciences such as economics, sociology and psychology.

Programmes based on real needs: target groups should be defined before developing any programme; for instance, the needs of rural women are different from those of city women, the needs of the handicapped are different from those of the general public. The specific needs of cultures and interests should be a driving force in programme development. Informal science and technology should target those groups who are in most need of such programmes, and the needs of those groups should be used to develop programmes.

Bottom-up not top-down: it is important to place a real emphasis on the ability of communities to be generators, not just receivers of science and technology. Informal programmes should be based on their own traditions, culture and experience. Community-generated informal programmes should be encouraged and supported by all regional and national science and technology initiatives. In particular women must be encouraged to play an important role in informal science and technology at all levels.

Begin with the children: by beginning informal education with the very young children, the seeds are sown for a greater awareness of science and technology in the future. Given the large percentage of young people in most developing countries, informal programmes must recognize the need to reach the very young as part of a strategy of building a commitment to lifelong education.

Recognize existing competence: informal science and technology programmes must recognize that most people have real competence in science and technology, even if this is not expressed in standard or conventional terms. This knowledge can be of equal importance and validity to that of conventional scientists and technologists. By starting with a recognition of existing skills, knowledge and competence, informal science and technology programmes can build on indigenous tradition, practices and cultures, thus reaching those normally ignored by both formal and informal systems.

Reach those who are outside the system: the informal system must be used to reach those who are normally outside the reach of existing systems. Informal science must take advantage of all available existing networks to reach people where they are: in day care centres, in markets, in villages, in churches, in hospitals. The informal system cannot wait for people to come to them.

Don't imitate: imitating 'glossy' programmes or building spectacular science and technology centres on models borrowed from the Western context is unlikely to be appropriate for developing countries in establishing non-formal and informal programmes. It is important to do things in a way which is appropriate to, and within, the reality of the needs and culture of a country.

Encourage diversity: it is good to have a diversity of experience in a single network of informal science programmes - a principle as valid in the experience of AMSCTI (Association des Musées et Centres pour le Développement de la Culture Scientifique, Technique et Industrielle) in France as in Africa. The creation of regional networks to link centres of informal science helps to increase the reach of informal science. Networks are a powerful means of encouraging diversity, especially when existing networks not traditionally associated with education are used, such as hospitals, day care centres, markets, agricultural fairs and public libraries.

Connect with the real world: formal institutions of learning are often involved in preparing students to obtain employment. Consequently, there is often a big gap between school science and technology, and real world science and technology. Non-formal and informal programmes should contribute to bridging this gap. Moreover, informal science can help sensitize people to the importance of real world concerns such as environmental protection, recycling and health care.

Train informal communicators: training of informal science and technology communicators is an important initiative in all fields of informal science and technology. Training people in knowledge of scientific methods, the strengths of the scientific approach and communication are an indispensable part of creating grass-roots support for informal science. Informal training programmes should respect the importance of indigenous traditions and culture, and local leaders should be encouraged to play a leading role in science and technology communication in their communities. In particular women must be encouraged to take leadership roles in informal science and technology training at the community, regional and national levels.

Certain examples drawn from the participants' experience demonstrate the ways in which these points of consensus can generate innovative informal science and technology programmes. They include primary science and technology programmes in multicultural day care centres, travelling exhibitions, touring libraries and hospitals, science theatre events at agricultural fairs, science-by-mail, grass-roots biology programmes in the field and use of folk media in communicating science and technology in rural communities.

THE REGIONAL GROUPS

AFRICA GROUP

Prof. Sam 'Tunde Bajah, Chairperson
Prof. Peter Okebukola
and
Ms Topoyame D. Mogotsi, Rapporteurs

The main thrust of the meeting was presented by the Chairperson as:

- identification of projects at the national and regional levels which can help to promote the achievement of the goals of Project 2000+; and
- description of strategies and mechanisms for implementing the identified projects at the national and regional levels.

The Director of the UNESCO Regional Office in Dakar (BREDA) Professor Pai Obanya stressed the need for collaboration by African countries in implementing projects which are relevant to Phase 3 of Project 2000+. BREDA could offer support in facilitating such collaboration within limits of resources available to the Office. The Regional Advisory Committee on the Renewal of Science and Technology Education in Africa is serviced by BREDA and it considered Africa's contribution to Project 2000+ at its last meeting.

1. Country Reports Related to the Goals of Project 2000+

Country reports were presented from Ghana and Nigeria. In the Ghana report, descriptions of the following projects were presented:

- Project for Science Integration (PSI)
- Science in Ghanaian Society Project (SGSP)
- Primary Science Project

The Nigeria report identified the following projects:

- Junior Engineers, Technicians and Scientists (JETS) Programme
- Each-One-Teach-One or Fund-the-Teaching-of-One (EOTO/FTO) Project
- Science Teacher Association of Nigeria (STAN) National Workshop Series
- The World Bank-Assisted Primary Science Project
- Federal Ministry of Education (FME) Teacher Vacation Course
- Nigerian Conservation Foundation (NCF) Environmental Awareness and Education Project
- Distance Learning Projects of the Correspondence and Open Studies Unit (COSIT), the National Teachers Institute (NTI) and the University of Abuja

- Nigerian Integrated Science Teacher Education Project (NISTEP)
- National Primary Science and Mathematics Project (NPSMP)

Some implementation strategies were suggested which include the formulation of a national policy on scientific and technological literacy for all and the setting up of implementation committees at the federal and state levels on the policy.

2. Report from the Advisory Committee on the Renewal of Science and Technology Education in Africa

The Advisory Committee on the Renewal of Science and Technology Education in Africa, in a report presented by its Chairperson, identified as major objectives of a programme on science and technology education for all:

- to equip Africans, irrespective of present and future career orientations, with basic knowledge, skills, attitudes and values in science and technology which have potential for improving the quality of life in the region;

- to provide a foundation for further education and training in science and technology for those who will ultimately go into careers in science and technology;

- to facilitate social, economic and political development in the region;

- to increase the pool (in quality and quantity) of scientists and technologists in Africa.

Six target groups were identified. These are the formal school population, out-of-school population, the work force, the educated adult section of the population of scientists and technologists outside their own field, girls and women who are usually marginalized, and people with special needs in the population.

3. Report from the Interim Coordinating Team of the African Network for Research and Development in Science and Technology Education (ANERSTE)

The interim coordinating team of ANERSTE informed participants of the formation of the network in January 1993. The interim Regional Coordinator gave information on two proposed projects - the publication of an ANERSTE Newsletter and that of a Who's Who in Science and Technology Education in Africa. Suggestions were sought on national contact persons, funding, and regional organisation and coordination.

4. Deliberations

In order to facilitate the work of the group, strands were identified which discussed the focus areas of Project 2000+ within the context of the African region as well as projects for national, sub-regional and regional activities. The following conclusions emerged:

Strand A: School Curriculum and Resources

Present situation:

- most of the curricula used are not well-developed;
- teachers are not well-prepared to handle the curricula;
- available material resources are insufficient.

Strategies:

- there is a need to re-examine the science and technology curricula at the primary, secondary and tertiary education levels;
- sub-regional centres of excellence should be created;
- curriculum development centres should be strengthened in terms of human and material resources;
- high level training should be given to curriculum developers;
- women and girls should be encouraged to pursue science and technology education.

Strand B: Non-formal and Informal Education

Target Groups:

- illiterates;
- literate but S & T illiterates;
- S & T literate in their own disciplines but illiterate in other disciplines;
- children - school; preschool; street children

Recommendations:

(a)

- visual and audio aids in public places (loud speakers, mobile units);
- S & T adult education in mother tongue in numeracy, reading, writing;
- multi-purpose centres for skill development, e.g. weaving, tie dye, lectures, indigenous technology;
- cooperatives for women and farmers;
- exhibitions (mobile or fixed), S & T Road Shows (role models, etc.); awareness campaigns through radio, TV.

(b)

- In addition to the above, lectures and multi-media information (including books, newspapers, etc.).

(c)

Children

- School age
- S & T clubs, e.g. JETS in Nigeria and Expo-clubs in South Africa;

- S & T Fairs, excursions and competitions
- Pan-African Science & Technology Olympiad
- Science and Technology Centres

Preschool
- games, toys
- home teaching
- family S & T
- science centres

Implementation:

(a) add S & T to adult education, where it exists; in any case, provide adult education for all.

(b) involvement of ministries, parastatals, associations, public-spirited individuals, UNESCO.

(c) inventory of indigenous technology across linguistic and geo-political barriers.

(d) exhibitions, S & T 'Road Shows' (role modelling, especially for women and girls).

(e) inventory and coordination of indigenous technology, extension services and all S & T programmes available across geo-political boundaries.

Priorities:

(a) Children
- S & T clubs;
- Pan-African olympiads (resulting from national S & T olympiads);
- Preschool games and toys;
- Street children skill development;
- Science centres and museums.

(b) Adults
- S & T adult education in mother tongue (with priority given to women);
- S & T awareness campaigns in public places through multi-media (emphasis on women and girls);
- extension services and indigenous technology (emphasis on women), including cooperatives.

Strand C : Teacher Education and Leadership

The group noted that creative design and technology is rarely mentioned in most countries, that teachers of science and technology are lacking in confidence due to inadequate training: teachers do not have a positive role concept as facilitators in the community. There is a major need for in-service training not only for teachers, but also for *teacher educators for science and technology*. The group recommends that the following projects be developed (prioritized) :

- a Comparative Study of Teacher Education for Science and Technology across a number of countries, and following this review, curriculum development in teacher education (for primary and secondary levels). Particular attention should be directed to:
    - indigenous science and technology,
    - use of local materials,
    - maintenance of equipment;
- a sub-regional workshop for 'Training the Trainers of Science and Technology Teachers' (i.e. science and technology specialists together);
- INSET courses for head teachers, principals and administrators to make them aware of changing goals in science and technology education;
- science and technology education resource centres to be set up in all countries of the region;
- a project to address the supply and retention of teachers of science and technology.

Strand D : Framework Mechanisms and Strategies

Proposals:

Principles governing the operation of the structures:

- accountability;
- transparency;
- accessibility;
- capacity-building.

Structures:

The proposed structures comprise a Regional Coordinating Committee (RCC), Sub-regional Coordinating Committees (SCC) and National Task Forces (NTF).

National Task Forces (NTF):

- composed of groups which have wide support;
- promote Project 2000+ with particular reference to Strands A - C within the context of the World Conference on Education for All, Jomtien, 1990;
- identify, promote and prioritize national projects.

Sub-regional Coordinating Committees (SCC):

- composed of one representative from each NTF within the defined region;
- promote regional cooperation and networking;
- promote regionalization of projects;
- coordinate activities of regional projects;
- raise funds for regional projects;
- help raise funds for national projects;
- ensure accountability of national projects.

Interim Operation and Time Frame:

National Task Forces (NTF):

- promote Project 2000+ at the national level;
- establish a *mandated* NTF by 31 December 1993;
- nominate an interim person to carry out the above tasks for each country in Africa; the mandate of such person to expire when the mandated NTF is established.

Sub-regional Coordinating Committees (SCCs):

- nominate two interim SCC representatives at the present meeting (8 July 1993);
- tasks:
    - to identify and mandate interim national representatives for countries not represented at the Forum;
    - to convene the first SCC by 31 March 1994. At this meeting they will: discuss project proposals or plans of action for their countries brought by the NTF representatives;
    - develop a regional plan of action;
    - develop a framework which gives expression to functions of the RCC as laid down in the structures.

The mandate of the interim RCC representatives terminates at this meeting.

Regional Coordinating Committee (RCC):

- comprising one representative of each SCC;
- raise funds which would establish the RCC;
- develop plans of action for the establishment of a viable network to create databases, facilitate exchanges of human and physical resources, produce a relevant publication to pull together the reports of four strands, which will be sent to the interim RCC, which will then pass it on to interim national representatives by 15 August 1993.

5. Recommendations

Following the consideration of the strand reports, the group made the following recommendations:

1. Each country in Africa should set up, as a matter of urgency, but not later than December 1993, a National Task Force on Project 2000+. (National contact persons were identified to facilitate the formation of the task force).

2. National Project proposals with development guidelines, time-lines and evaluation support should be prepared by the National Task Forces soon after formation.

3. Sub-regional Task Forces should be set up after the formation of the national task forces.

4. A regional network should be created noting the following:

    (a) The network should, in particular, support the interests of the major linguistic groups of African countries;

    (b) Preparatory activities, (e.g. drawing up of a draft constitution, and a draft work plan) should be initiated towards the formation of the network.

    (c) There should be a formal launching of the network during which there will be a training activity for national STL leaders and the development of regional guidelines for levels or bench marks of STL.

5. The UNESCO Regional Office in Dakar (BREDA) and other UNESCO offices in Africa should play an active role in facilitating the setting up and operation of the network.

6. Proposals should be prepared with regional consensus.

7. Plans for coordinating national, sub-regional and regional proposals should be worked out.

ARAB STATES GROUP

Dr M. El-Nemr, Chairperson
Dr M. Mrayati, Rapporteur

STL plays an essential role in the national, environmental and human development in the Arab States. The concept of STL is fundamental to the current educational thinking, the future of the teaching profession and the impact of mass media on the educational systems. A state of educational-intellectual alert is well-justified among the peoples of the Arab Region.

In the context of the necessary large-scale multidimensional development of human and natural resources, Project 2000+ is of the utmost relevance. Recent endeavours within the Arab region in this area demand a framework for more productive action.

The attainability of a cooperative plan of action depends on a proper understanding and awareness of the theme *STL for ALL* by all who will be engaged in launching Phase 3 of Project 2000+ in the Arab region. The following are the guidelines for a plan of action for initiating and launching 'Project 2000+ Phase 3' in the Arab region:

1. Objectives

Assuming that Phase 2 will provide the philosophical and pedagogical rationale for STL, the following objectives should be considered:

- promotion of the idea of Project 2000+ at the regional and national levels;
- development of regional and national task forces;
- provision of technical support for all stages of developing national programmes.

2. Organizations and Agencies

The following will be approached to achieve the above objectives:

- UNESCO regional offices;
- UNDP;
- ALECSO, ISESCO;
- sub-regional organizations;
- ministries of education & culture;
- national science education organizations;
- Arabsat.

3. Procedures:

- UNESCO could supply Project 2000+ documentation to all the identified bodies;
- participants in Phase 2 will approach the above organizations and agencies -personally or by mail, to recruit task force personnel at the national level (see Document ED-93/CONF.016/8, Annex 1, Potential Members of a National 2000+ Task Force);
- planned meetings of the task force at the national level should take place to identify the main issues and projects which are relevant to STL in each country (particularly those of revising and developing science and technology curricula in pre-college education, improving teacher education programmes, promotion of informal STL national campaigns, creation of new assessment methods and materials relevant to STL, and establishing centres for supporting the improvement of science and technology education in the country);
- task forces should decide what the most appropriate projects are, taking into consideration the particular local characteristics of each country;
- task forces should approach international agencies for support of the proposed projects;
- task forces should seek financial assistance and resources from: the government, industry, and the private sector, as well as from individuals.

4. Areas of Cooperation

In order for STL to achieve maximum impact, certain lines of coordination should be established as early as possible while initiating Project 2000+ Phase 3 in each country. Relevant aspects of integrated action include the following:

- creation of a database for resources in the field of STL, accessible by all task forces (regional, national, sub-national);
- Arabization of the most appropriate materials so that the implementation of STL education is enhanced;
- exchange of local databases on STL;
- exchange of field-test results of the implementation of new materials;
- encouragement of regional meetings of interested bodies and organizations to share knowledge and expertise;
- enhancement of all types of informal activities aiming at STL for children, youth and adults, preschool, in-school, out-of-school, and after school.

5. Means of communication

- Arabsat should be utilized for large-scale, long-distance exchange of the elements of STL;
- use should also be made of Fax and regular mail;
- printed newsletters or journals :

(a) already existing:

- IOSTE Newsletter;
- UNESCO's International Network for Innovations in Science and Technology Education (INISTE);
- Prospects (UNESCO);
- New Education (UNESCO);
- Science (ALECSO);
- Studies in Curricula (Egypt);
- Science and Technology Magazine (Lebanon);
- and other international magazines and periodicals.

(b) a specialized STL newsletter could be created to add more views and information concerning the regional affairs corresponding to the different aspects of STL.

ASIA AND PACIFIC GROUP

Prof. Peter Fensham, Chairperson
Dr Richard Lowe
and
Prof. Leo Rebello, Rapporteurs

The work of developing project ideas for the Asia and Pacific regional group was carried out within four subgroups, each of which had a nominal focus on one of the following areas:

- primary education;
- secondary education;
- tertiary education (including teacher education);
- non-formal/informal education.

Prior to splitting into subgroups, the regional group as a whole was told of existing projects from a variety of countries which might be useful illustrations of what could be done to develop scientific and technological literacy. These were:

- a non-formal education programme in Thailand to develop scientific and technological literacy within rural communities;

- a pilot assessment and evaluation programme in the Philippines to determine the extent of scientific and technological literacy across a broad range of educational settings;

- a research programme in New Zealand to investigate the existing capabilities of students with respect to science and technology as well as their understanding of the role of science and technology in their lives;

- a development programme in Iran to devise and implement a contextually appropriate primary science course which reflects current perspectives on science and technology;

- a development programme in Malaysia to produce a primary science course which is focused upon developing scientific and technological literacy in a manner which has local relevance.

Project Ideas:

Using the above illustrative example projects as a springboard, the four subgroups then developed ideas for new projects which could be used to develop scientific and technological literacy at national and regional levels. Although these project ideas were developed here within the subgroup framework, it should be noted that some of the proposals would span several of these areas.

- Strengthening existing national and regional support networks for scientific and technological literacy projects (countries in the region);
- Developing contextually appropriate definitions of scientific and technological literacy (India);
- Industrial visits for upper advanced level science students to develop their scientific and technological literacy in preparation for university entrance (Sri Lanka and some other countries in the region);
- Career education as a component of scientific and technological education and other links to the world of work (Philippines, Japan, Ireland, Australia);
- Establishment of improved communications to facilitate networking of regional institutions for generation and sharing of curriculum resources (Thailand, United Kingdom, Solomon Islands);
- Development of human and material resources for professional development in science and technology teaching (Australia, Philippines, Iran, Thailand);
- Distance education programmes for the development of scientific and technological literacy (India, Iran, Australia);
- Development of alternative assessment and evaluation approaches appropriate for scientific and technological literacy (countries in the region);
- Promotion of scientific and technological literacy through teacher development, assessment and evaluation via coordination of national efforts through UNESCO and in particular the Asian Programme of Educational Innovation and Development (APEID) (countries in the region);
- National programme to train teachers and administrators to develop adult literacy with respect to science and technology (China);
- National programme for out-of-school activities for children to develop scientific and technological literacy to enhance national development (China and other countries in the region);
- Girls and women learning about the science and technology of local materials (India, China, Thailand, Papua New Guinea, Japan, Sri Lanka, Philippines, New Zealand, Indonesia);
- Regional training workshop for those working with the developments of scientific and technological literacy for women and girls using non-formal/informal methods (countries in the region).

Commitments to Personal Initiatives for STL Developments following this meeting:

- Encouragement of classroom use of science education research via teacher involvement in research and workshops with science teacher associations (Philippines);
- STL aspects of physics education across various levels of education (Japan);
- Joint communication to Ministers of Education informing them of issues and outcomes regarding Project 2000+ and suggesting support and funding for a meeting on the relation between science education and technology education (Australia);
- Indonesian Association for Science to run education seminars for science and technology education and to invite overseas participants as guest lecturers for STL emphasis (Indonesia);
- Non-formal adult education at centres located across India using courses in local languages to cover issues associated with general as well as scientific and technological literacy with emphasis on health education (India);
- Initiatives to target the general public regarding the importance of STL consciousness-raising (Australia);
- National symposium on verbal and visual language with respect to the development of scientific and technological literacy (Australia);
- Maths and science associations to develop school science club members' interest in industrial aspects relevant to STL and to prepare associated materials (Sri Lanka);
- Organization and base for international science week in Thailand in August 1994. Also the ICASE symposium on equipment and computers for science and technology application (Thailand);
- Organization of coordinated research on assessment of scientific and technological literacy involving a broad range of relevant organizations (Indonesia);
- Youth forum on 'Biodiversity of our Future' to be held in October 1993 (China);
- Workshop for key workers in provincial level scientific and technological programmes to be held in December 1993 (China);
- Assessment of scientific and technological literacy of various sectors (Philippines);
- Developing awareness of the need for STL for the 21st century among school students (Sri Lanka).

EUROPE AND NORTH AMERICA GROUP

Group leaders

Dr Blagovest Sendov, Chairperson
Dr Peter Kelly, Rapporteur

The group established five subgroups:

Science and Technology Education for the Environment
    Dr Alicja Wojtyna-Jodko, Chairperson/Rapporteur

Science and Technology Education - separate or integrated?
    Mr John O'Brian, Chairperson
    Mr John S Smith, Rapporteur

Cooperation between Europe and North America.
    Dr Herbert D. Thier, Chairperson
    Mr Bernard Farges, Rapporteur

Primary Science and Technology Education.
    Dr Wynne Harlen, Chairperson/Rapporteur

Cooperation between Formal and Non-formal Education.
    Dr Katarína Teplanová, Chairperson/Rapporteur

Initially each subgroup discussed principles and needs related to their topic and, in this way, linked their proposals for action to the ideas discussed in the Focus Area Groups.

Each of the subgroups established their own network of contacts and agreed to share information about activities and foster future activities amongst themselves.

It was a shared opinion of the subgroups that the key aspect of immediate future activity was not to create new projects but to ensure adequate dissemination of information about current ones. In this connection the availability of the International Organisation for Science and Technology Educators (IOSTE) database of about 1000 projects was noted and it was agreed that its use and size should be expanded if at all possible.

The importance of maintaining the momentum of activity created by Project 2000+ was also stressed by all of the subgroups. It is proposed that at future conferences on science and technology education, events should be included which will enable participants in Project 2000+ to come together to share the values of their on-going experiences. The IOSTE conference in 1994 was seen as a good beginning for this.

Other key proposals for action from the subgroups were:

1. Science and Technology Education for the Environment

- to develop and strengthen links between education and environmental industry and activities to heighten environmental awareness of decision-makers;

- to evaluate and assess science and technology education materials related to the environment in different ways:

    their potential for providing opportunities to learn, which includes considering the child's own concepts and percepts (particularly important for environmental values);

    their effectiveness in changing students' attitudes, which depends on the teaching strategies used; there is doubt as to the value of the formal lecture mode, but small group discussions amongst the students should be encouraged. Empowering action is also difficult in relation to many global issues since they are outside the locus of students' control; teaching may start with technological products and investigate ways in which the products and the manufacturing processes affect the environment;

- to establish a database of material directly useable by the teacher; this should include activities which may be used to investigate the local environment. Since there are already examples in some countries, the database should make them widely available;

- to develop case studies of new manufacturing processes which produce material causing less environmental damage (e.g. paper and pulp, detergents, ...)

- to ensure that all environmental teaching should be informed by the Brundtland report, especially the concept of 'thinking globally, acting locally'. The report also emphasises the importance of interdisciplinary in science and technology teaching and this, in turn has implications for the structure of secondary and tertiary level science and technology education.

2. Science and Technology Education - separate or integrated?

- to undertake a 'needs analysis' concerned with the particular knowledge and skills required for science and technology education in the primary and secondary schools in each country as a basis for future action and to report on the findings to appropriate meetings;

- to obtain and disseminate information about successful teacher training programmes;

- to undertake cooperative comparative studies of science and technology teaching, methods of assessment and teacher training, as an extension of the above.

3. Cooperation between Europe and North America

- to develop materials and activities for science and technology education which reflect the diversity of languages, culture and social systems found within countries. Especially to undertake research on the influences of language diversity on teaching in science and technology. In most countries, real change requires the active commitment and participation of the classroom teacher. It is of critical importance for teachers to receive classroom materials and research reports and findings in the languages in which they teach.

4. Primary Science and Technology Education

- to develop guidelines to help teachers adapt existing materials, methods and classroom management so that opportunities are provided for achieving the goals of STL;

- to extend present projects on assessment in primary science to include technology and to give special attention to STL;

- to initiate, in each country represented in the subgroup and within one year (i.e. by July 1994), a meeting at which the need for, nature of, and ways of implementing, STL in the primary school will be studied and translated into a product/report.

(The results of these actions and initiatives will be disseminated by ICASE.)

5. Cooperation between formal and non-formal education

- to encourage the development of national science education centres for the provision of non-formal science and technology education;

- to encourage the provision of travelling interactive exhibitions on national, regional and international levels wherever possible;

- to develop materials and encourage the incorporation of non-formal elements of science and technology education in formal education;

- to explore ways of using networks between community groups (women, youth, senior citizens) to enhance scientific and technological literacy in the community;

- to develop sensitive methods for evaluating the impact of non-formal activities in science and technology education;

- to disseminate expertise on modes of non-formal learning in science and technology, with reference to educational aids, scientific toys, interactive exhibits and the public media;

- to develop networks based upon existing trans-national organizations with responsibility for non-formal education in science and technology and to link these to the formal sector in the development of concepts, methods and approaches;

- to exchange experiences between national groups in non-formal science and technology education, leading to recommendations based upon the conclusions of international conferences, workshops and seminars; such conferences to be precisely focused upon specific issues.

- to provide support for the development of professional and volunteer staff in the non-formal sector, through scholarships, study tours and exchange visits.

Note on Distance Learning for Teachers

by

Dr Lucia Ciarrapico and Dr Paolo Brandolin

There are distance learning projects in many parts of the world, such as open universities in the United Kingdom and Spain, and a distance teacher training project in Italy. Through the use of radio, television and other media, these and other projects make valuable contributions to the education of students and teachers, particularly in adult education and professional programmes. UNESCO should help to establish a database and network of such projects concerned with promoting scientific and technological literacy and so enable them to share experiences and, where appropriate, materials.

LATIN AMERICA GROUP

Dr Luis A. Romo, Coordinator
Lic Maria Laura Ferreyra, Rapporteur

1. Introduction

Participants gave brief accounts of what is being currently done in their own countries in the field of science and technology education for all.

Countries which have initiated task forces at the request of UNESCO:

Brazil: The main efforts to popularize science and technology are not centralized, since work patterns and work cultures vary in different regions of the country. The task force is based on leadership and already interacts with municipal authorities and universities. Now, it is starting to cooperate with labour unions, firms, etc.

Chile: The representative from Chile was unable to attend the Forum but the report sent indicated that a national task force had been initiated and that several projects with potential contribution to scientific and technological literacy had been identified. It was also noted that the Chile Ministry of Education has many on-going projects: Basic Integrated Science (CIBEX), Environmental Education (PRODAM), Improvement of Quality and Equity in Education (CEME), Marine Sciences (EDUMAR), etc. Out-of-school science and technology education projects are also being supported.

Ecuador: The National Research Council and the Task Force 2000+ will strengthen activities to popularize science and technology. The aim is to introduce the population to the benefits which science and technology can provide to improve the quality of their lives. This will be done by the disclosure of science and technology knowledge to the general public. These activities will involve universities and NGOs and they represent an endogenous effort to generate science and technology literacy in children and teenagers, although foreign help is welcome and expected.

Panama: This country has recently created the National Council for Science and Technology, which is integrated by government, firms and NGOs representatives. There is an agreement between government and the Association for the Advancement of Science in Panama (APANAC) which provides advice to the government on issues related to public and private education. Also, there is an agreement between the government and Japan to build a Science Teaching Center in Panama.

Other countries in the region:

Argentina: Current projects try to solve the following: production of equipment for science and technology teaching (made by researchers and users); upgrade of science and technology backgrounds of those high school students who intend to proceed to university; workshops for teachers to train them to act as secondary popularizers of science and technology (among others the Mutual Association project 'Science for All' in association with the Ministry of Education), and interaction of school students with people (of their community) which use science and technology knowledge and skills (researchers, managers and workers at firms, etc).

Colombia: Participants presented Project Cucli, which is aimed at 6-12 years old children as a complement for school activities. It makes use of a booklet and a mural periodical publication, and will include videos and mass media support. The Ministry of Education is working to introduce technology education in school curricula, involving teacher training and the development of educational material. Important work at universities concerning graduate education in science and technology and projects undertaken by private foundations were also mentioned.

Mexico: Work is being done by professional associations which wish to develop community interest and awareness in their field of expertise, and also to obtain a better community-university relationship in science and technology. Two specific projects were considered: 'Science from Mexico' which involves publishing more than 100 books on science and technology, and the Latin American Society for History in Science and Technology. Other network pilot projects were considered.

Venezuela: Efforts to create a network of centres for the popularization of science and technology were mentioned and the importance of the exchange of researchers and students was stressed.

2. Identification of Key Issues

Analysis Procedure

Participants decided to identify the main problems after selecting possible contexts for action, involving formal, non-formal, and informal activities for STL. These contexts were divided into regional and national. The national context refers to governmental and nongovernmental organizations (NGOs), academic and scientific communities, communication media and popularization centres. Such contexts were used to identify possible activities in training, research, information exchange, design, production and exchange of materials, and program financing.

(a) Training:
Exchange of experiences, training materials and people within the region is crucial, including the active participation of private and public sectors. In particular, in-service training of teachers and promotion of regional efforts for the exchange of graduate students are recommended.

(b) Research:
Endogenous development and optimization of financial and technical support provided by UNESCO, OAS, other international organizations and NGOs, need to be supported by the creation of databases and directories of researchers involved in STL, as well as explicit consideration of community problems in the development of research programs concerning popularization and education.

(c) Information exchange:
Databases and information networks must be supported and strengthened.

(d) Design, production and exchange of STL materials:
This crucial activity requires more support, particularly to overcome poor communication infrastructure and scarcity of financial resources.

(e) Programme financing:
Implementation of STL projects should be primarily financed endogenously. External aid should be sought for critical or strategic projects which can not be executed with national resources. Up to the present, one of the main sources of financial and technical support for the region has been the OAS. Therefore, participants would like to ask UNESCO to stimulate increased assistance in order to assure success. Also, the participants expressed the need that UNESCO assigns a higher priority to STL projects within the region, taking into account severe social problems which require immediate and urgent solutions.

3. Recommendations

Participants agreed that there is a growing need for task forces to coordinate the efforts of the governmental institutions, NGOs, universities, and teachers. The actions of NGOs were considered of fundamental and of increasing importance; their independence and individuality when interacting with other institutions were stressed. The creation of regional and national networks of NGOs to work on STL drew great support from the group. It was felt that governments must assume a serious engagement with the fostering of STL by giving it high priority in their plans of action.

It was also considered important to invite organizations which have not been traditionally involved in STL to join the Project 2000+ task force. Some of these organizations are social welfare institutions, labour unions, private firms, etc.

It was also felt that universities and institutions which belong to the educational system should orient their efforts to meet the needs of their local and regional communities and that their extension and research activities related to STL should receive more support in the future.

UNESCO Regional and field offices are expected to play a very important role in the national and regional exchange of information and materials and in the search for external funding. For this purpose, UNESCO regional networks such as that for teacher training institutions (PICPEMCE), that for educational planners and administrators (REPLAD), the literacy network (REDALF), the system of information on educational statistics and indicators (SIRI), etc., can play a significant supportive role.

A more extensive use of electronic communication networks is required. Some examples of this type of networks are: Project Hurricane, Internet, and the memory center at the University of Sao Paulo in Brazil.

The following proposals are also suggested for the development of the national STL task forces:

(a) Informal education:
Revision of education curricula related to science and technology; development and production of materials and workshops regarding learning and teacher training materials; creation of appropriate centres and facilities for supporting STL, and promotion of out of school activities.

(b) Non-formal and informal education:
Production of mass media programs for STL; updating knowledge, skills and values needed for STL, and promotion and support of voluntary associations and networks.

The group expressed their view that the selection of the above mentioned items reflects its background and action framework, and that it does not necessarily represent the whole range of interests and problems which may be addressed by the national task forces.

SMALL ISLAND STATES GROUP

Ms Lucy Steward, Chairperson/Rapporteur
Members of the group came from Barbados, Iceland, Mauritius, Trinidad and Tobago

Achieving scientific and technological literacy through exploration of issues of relevance to Small States

1. Issues

Recycling wastes
Protecting lagoons, coral and mangroves
Utilising wind and solar energy
The home
Protecting beaches from erosion
Food security and utilising small space
Use of herbs and traditional medicines.

2. National Task Force

The group agreed with the composition of a Task Force, proposed by UNESCO (see document ED-93/CONF.O16/8, Annex 1, Potential Members of a National Project 2000+ Task Force). They also agreed that:

- the selection of persons should be made at national level;
- the Task Force should comprise about fifteen persons;
- the Task Force can appoint subcommittees for specific tasks and that these committees should comprise Task Force members and others selected for their particular expertise.

3. Regional Coordination

Regional coordination of the work of the National Task Force in each Member State can be carried out by existing regional bodies.

Examples of Coordination Mechanisms:

- Caribbean Region - CARICOM/UNESCO

- Atlantic Region - UNESCO in collaboration with the University of Iceland, or Teachers University College, Iceland
- Pacific - South Pacific Regional Environmental Education Programme; University of the South Pacific
- Indian Ocean - Indian Ocean Commission East African Regional Seas Programme

Regional coordinating bodies can also use existing regional mechanism to facilitate/monitor specific projects.

4. Suggestions for Projects

The group put forward the following suggestions for projects to implement Phase 3 of Project 2000+ in Small Island States

Project Outline 1.

Name:

Public campaign for scientific and technological literacy

Target Groups:

The public, policy and decision makers, media personnel, special groups e.g. family

Rationale:

Educating the public for scientific and technological literacy will also contribute to the creation of a supportive environment for science and technology education. A public campaign will enable the media and the public to improve their understanding of science and recognise the uses and the limitations of technology.

Objectives:

To develop a public awareness programme for scientific and technological literacy.

Operating Guidelines:

Selection of science and technology themes that relate to human and country specific needs. Production of public awareness programmes by a team which comprises media personnel, scientists, technologists and educators as well as representatives of community groups. Programmes will include TV, video, radio programmes, 'talks' at community level, newspaper articles, slogans, posters, brochures, etc. (multimedia).

Project Outline 2.

Name:

Development Activity Oriented Materials for Science and Technology in the Home

Target Groups:

Families

Rationale:

Activities on *S & T* which involve students and their families can contribute to the achievement of the goal of scientific and technological literacy. This project is therefore for the development of materials which are enjoyable and will enable both students and parents to acquire knowledge, skills and desirable attitudes for scientific and technological literacy.

Objectives:

To develop activity materials for scientific and technological literacy for use by students and their family.

Operating Guidelines:

Establishment of a multisectoral team for development of materials. Field testing of materials. Revision, publication and dissemination. Evaluation of impact.

Project Outline 3.

Name:

Development and implementation of out-of-school science and technology activities

Target Groups:

Students in formal and non-formal education programmes, parents, community groups, etc.

Rationale:

Scientific and technological literacy can be promoted through out-of-school science and technology popularization activities. These can include science fairs, science clubs, science camps, museums, science games, etc. This proposal is for the development and strengthening of out-of-school science activities.

Objectives:

To develop and implement science and technology popularisation activities.

Operating Guidelines:

Establish a team (multisectoral - science association, industry, scientists, etc.) to develop a comprehensive programme for out-of-school science and technology popularisation activities. Implement programmes at school level and at community level. The team will monitor and evaluate projects.

Project Outline 4.

Name:

Curriculum Development Projects for Primary and Secondary Teacher Education in Technology

Target Groups:

Preservice and in-service primary school teachers

Preservice and in-service secondary school teachers

Rationale:

Programmes of scientific and technological literacy in the formal sector are needed to support such efforts in the non-formal sector. The need for such programmes in technology education is urgent becauce technology as a separate subject does not now exist in many small States. Teacher education programmes are an obvious first step in implementation of STL in the formal sector. At both primary and secondary levels the need includes preservice and in-service training. The training should include both graduate and undergraduate teachers (or uncertified).

Objectives:

1. At the primary level - to equip all teachers with the knowledge, skills and attitudes needed to deliver technology education.

2. At the secondary level - to prepare a cadre of specialist teachers for technology.

Operating Guidelines:

- Development of content-based modules for technology teachers.

- Development of appropriate materials on the approaches/methodology for technology teaching.

- Support of vacation mobile-shops and phased short courses for those teachers whose training did not include exposure to the content and methodology of technology teaching.

The above to be implemented by primary and secondary teacher-training institutions.

Project Outline 5.

Name:

Technology Education for Teacher Educators

Target Group:

Teacher educators in colleges and universities involved in teacher education

Rationale:

Few programmes for the preparation of technology teachers exist. Effective implementation at the school level requires teacher educators with up-graded skills specific to technology education.

Objectives:

Provide teacher educators with the skills, attitudes and knowledge needed to prepare teachers to deliver the technology curriculum.

Operating Guidelines:

- Development of short courses to be implemented on a national or regional basis.

- Short exchange visits between teacher educators at different institutions in small States.

- Facilitation of collaborative research projects between teacher educators in small States to provide a research base to inform teacher education programmes for technology education.

Project Outline 6.

Name:

Curriculum Development at Primary Level for Scientific and Technological Literacy

Target Group:

Primary school pupils and teachers

Rationale:

This project is for the development of curriculum materials for use at the primary school to enable pupils at this level to acquire skills of scientific and technological literacy. The materials should be activity oriented and designed in such a way as to facilitate infusion in other subject areas.

Objectives:

To develop curriculum materials for use at the primary level.

Operating Guidelines:

A group of teachers, curriculum officers and experts (scientists, engineers, etc.) will develop curriculum guidelines and materials which will be field-tested, revised and published. Training of teachers to use the materials will be required. A system for updating and revising materials after a specific time should also be established as part of the process for curriculum reform and development.

Project Outline 7.

Name:

Curriculum Development at Secondary level for scientific and technological literacy

Target Groups:

Secondary school teachers and students

Rationale:

At the secondary level, instruction is usually subject bound. In the majority of instances there exists some form of curriculum material in a range of science disciplines. Very little exists however, in the case of technology education. Secondary science curricula are almost exclusively dictated by external examinations. This project envisages a break in this cycle of influence, opting instead to put into operation what it means to be scientifically and technologically literate and providing experiences to facilitate this. Through the provision of both formal and non-formal experiences, it is expected that teachers and learners will become more scientifically and technologically literate.

Objectives:

To develop curriculum materials for science and technology education with a focus on scientific and technological literacy.

Operating Guidelines:

A group of teachers with assistance from relevant experts will develop curriculum modules and learning materials, which will be pilot tested, revised, published and disseminated. Training workshops will be necessary to enable teachers to use the materials.

Project Outline 8.

Name:

Teacher conducted research in scientific and technological literacy

Target Groups:

Teachers, education researchers.

Rationale:

Proposed changes in science and technology education are fundamental and must be informed by new kinds of research. Teachers are crucial to the implementation of proposed changes and their expertise can also be used to conduct research which is problem-oriented, related to real life and at the same time rooted to the environment. In a small society, using teachers as researchers is very often the only realistic option for the implementation of research activities.

Objective:

To develop research skills in teachers in order to conduct research on scientific and technological literacy and to enable them to make better use of technology and understand the limitations of science and technology.

Operating Guidelines:

- Establish a system (using relevant expertise) to train a core of teachers in research activities.
- Identify problems to be investigated.
- Assist teachers in developing methodology and collecting data.
- Use existing structures (e.g. science teachers associations) or develop mechanisms for sharing findings among teachers who should be encouraged to use the findings to inform practice.

Examples of Research Themes:

- Use of the media to promote scientific and technological literacy (STL)
- STL to protect an island environment
- The role of the family in STL
- Values and attitudes in STL
- Characteristics of exemplary STL educators
- Public views on STL
- Role of professional organisations in STL
- STL for food security

PROJECT 2000+ DECLARATION

We, participants in the Project 2000+ Forum, meeting at UNESCO, Paris, France, from 5 to 10 July 1993:

1. *Recalling* the World Declaration on Education for All, in particular its recognition that 'sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development' and, further recalling recent worldwide expressions of concern for the environment and for the quality of human life, especially those contained in Agenda 21, the output of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992,

2. *Believing* that scientific literacy and technological literacy are essential for achieving responsible and sustainable development,

3. *Declare* our full commitment to the promotion of science and technology education for all in keeping with the World Declaration on Education for All, and our readiness to contribute through Project 2000+ to the concerted action set out in the Framework for Action to Meet Basic Learning Needs;

4. *Call* on governments, industry, public and private sector interests, and education and other authorities in all countries to:

    a) review critically existing provisions for science and technology education at all levels and in all settings with the aim of giving appropriate attention to development and maintenance of learning programmes responsive to the needs of individuals and communities;

    b) assign priority to the development and introduction of programmes leading to scientific literacy and technological literacy for all with the aim of achieving responsible and sustainable development;

    c) take such steps as may be necessary to ensure equity of access for everybody to science and technology education, notably for women and girls, young children and other under-represented groups;

    d) develop appropriate in-school and out-of-school opportunities, programmes, curricula and assessment procedures for science and technology education responding to the human needs of a scientific and technological society;

    e) ensure and support appropriate pre-service and continuing in-service provisions for those responsible for all forms of science and technology education;

f) encourage and support evaluation, research and development in science and technology education in both formal and non-formal sectors;

and to this end:

g) establish and support task forces involving partnership with public and private educational bodies and councils; these might include universities and other institutions of higher and further education, research institutions, libraries, interactive science centres, environmental areas and nature reserves as well as public and private bodies active in the fields of agriculture, natural resources, environment, health, industry, commerce and the media, and also organizations and individuals specially concerned with science and technology education;

h) recognize the central role of teachers in achieving scientific literacy and technological literacy for everybody, and enhance the status of careers in science and technology education at all levels;

i) recognize the capital role of institutions of non-formal education, such as museums and scientific centres, of the media (radio, television and the press) and of all other out-of-school channels for communicating knowledge of science and technology, in fostering scientific and technological literacy for all; and

develop activities designed to set science and its applications in a wider social and cultural environment;

j) ensure that adequate resources are available to achieve these aims;

5. *Urge* United Nations Agencies and other inter-governmental organizations to work together to initiate and support programmes which will advance the ability of countries and of populations to shape their own future in a scientific and technological society and which will increase the capacity of countries for designing, planning and implementing scientific literacy and technological literacy programmes;

6. *Urge* non-governmental organizations active in fields of science and technology education, as well as the social sciences, and professional associations of teachers and educators and educational organizations at all levels to:

enter into partnership with, and make their knowledge and experience available to, United Nations and other inter-governmental bodies as well as establish innovative programmes in a common effort to achieve the goal of scientific literacy and technological literacy for all; and

participate in national, regional and international programmes for the enhancement of scientific literacy and technological literacy for the improvement of the quality of life in all societies and for the achievement of sustainable development;

7. *Recommend* that UNESCO makes provision, within its Medium Term Plan (1996-2001) in the field of education, and in the context of Project 2000+, for an international programme to develop cooperation among all countries in the field of science and technology education, with particular reference to the promotion of scientific literacy and technological literacy for all:

This programme, conducted in partnership with the relevant and competent governmental and non-governmental organizations and agencies, should focus on regional and subregional cooperation and on strengthening networks for exchange of ideas, information, human and material resources for science and technology education, and actively seek to promote world-wide:

a) understanding of the nature of, and the need for, scientific literacy and technological literacy in relation to local culture and values and to the social and economic needs and aspirations of each country and its peoples, and also in accord both with the general aims of education for the all-round development of human personality and with human rights and basic freedoms;

b) identification of those issues concerning the applications of science and technology which are of special importance for personal, local and national development and their embodiment in educational programmes;

c) establishment of teaching and learning environments as well as supporting structures conducive to the achievement of scientific literacy and technological literacy for all;

d) formulation of guidelines for the preparation and continuous professional development of science and technology educators and leadership coupled with assistance to countries in giving effect to them;

e) development of effective communication, both verbal and visual, assessment strategies and evaluation programmes designed to enhance general levels of scientific literacy and technological literacy;

f) support for the non-formal and informal sector in its own right and support for development strategies which will help to stimulate and maintain lifelong scientific literacy and technological literacy;

8. *Recommend* that by the year 2001 there should be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.

APPENDICES

Appendix 1

PROGRAMME

Monday, 5 July	afternoon	Registration
	evening	Cultural Event
Tuesday, 6 July	morning	Opening Ceremony Plenary Session Introduction to the Work of the Forum
	afternoon	Meetings of Focus Area Groups
	evening	Opening of Exhibition and Reception
Wednesday, 7 July	morning	Meetings of Focus Area Groups
	afternoon	Meetings of Focus Area Groups followed by Meetings of Regional Groups
Thursday, 8 July	morning	Plenary Lecture Prof. T. Odhiambo Plenary Session Presentation of Focus Area Group Reports
	afternoon	Meetings of Regional Groups
	evening	Plenary Lecture Captain Jacques-Yves Cousteau
Friday, 9 July	morning	Meetings of Regional Groups
	afternoon	Visit to Cité des Sciences et de l'Industrie
Saturday, 10 July	morning	Plenary Session Presentation of Regional Group Reports Adoption of Project 2000+ Declaration Closing Remarks

Opening Addresses

Address
by
Mr Federico Mayor

Director-General
of the United Nations Educational, Scientific and Cultural Organization
(UNESCO)

6 July, 1993

Co-Chairs of the Forum,
Captain Cousteau,
Distinguished Participants,
Ladies and gentlemen

In March 1990, the representatives of governments, international agencies and NGOs from all parts of the world met in Jomtien (Thailand) at the invitation of UNESCO, UNDP, UNICEF and the World Bank and adopted the World Declaration on Education for All. This pledge and its associated Framework for Action committed them to working together within the broadest possible international partnership to ensure basic learning opportunities for all the peoples of the world. Three years later the drive to make the Jomtien Declaration a reality continues : the latest initiative involves a concerted attempt by nine of the most populous developing countries - comprising some three-quarters of the world's adult illiterates and a sizeable share of its out-of-school children - to mobilize new efforts and resources in support of the goals of Education for All.

The logic behind this undertaking is clear : if we are to fashion a world in which the extremes of poverty and deprivation are reduced if not eliminated, if we are to lessen the current threats to our environment and to the maintenance of peace within and between peoples, if we are to halt the runaway trend towards unsustainable population levels, if we are to realize the tremendous potential for individual and collective fulfilment and well-being that underdeveloped human resources represent, then we have to make basic education a universal fact and not merely a universal right.

We have to do this, but we have to do **more** than this. We have also to ensure that the basic education provided satisfies the essential criteria of relevance and quality. In an age when the unprecedented and irreversible advances of science and technology are - for better or worse - changing the world day by day, hour by hour almost, who can doubt the need for any education worthy of the name to include a substantial science component ? Just as education can no longer afford to assume that its essential purpose is to cater for the scholastically gifted, for future university entrants, for the Nobel laureates of tomorrow, so it can no longer afford to maintain the artificial distinction between those who are suited to the sciences and those who are predestined for the humanities. Efforts to achieve Education for All must therefore be closely linked to a worldwide drive to raise levels of scientific and technological literacy. In practice, this means ensuring sound numeracy, a grasp of the fundamental concepts and methods of science together with the development of elementary problem-solving skills and associated decision-making capacities. All are required in a world in which political, economic, social and ethical considerations have become inextricably linked with the consequences of scientific and technological advance.

The Earth Summit in Rio de Janeiro last year highlighted the very real **practical** need to encourage the development of science and technology education worldwide. If the interlinked challenges of protecting the environment and promoting development are to be effectively addressed, this will call for substantial capacity-building in the relevant scientific and technological fields. In all countries and particularly in the developing countries, the establishment of a strong science and technology base is essential to the effective implementation of Agenda 21.

The need to train up expertise in order to pursue the goal of sustainable development is not however the only reason for boosting scientific and technological literacy. In a world increasingly shaped by science and technology, scientific and technological literacy is a universal requirement if people are not to be alienated in some degree from the society in which they live, if they are not to be overwhelmed and demoralized by change, if they are to have the basic knowledge and understanding to make those multifarious political, environmental and ethical choices with which scientific discovery and its consequences are confronting us all. In this respect, it is vital to improve scientific and technological literacy among women and girls, whose unique educational function within the family makes them such a major determinant of the attitudes of present and future generations. General scientific and technological literacy is also essential to ensure that decision-making at all levels - and notably among governments - is more firmly rooted in scientific fact and analysis. We need, through educational means of all kinds, formal and non-formal, to bring about a much more thorough infusion of scientific and technological culture into society. Only in this way shall we succeed in creating the continuum, the virtuous circle encompassing the establishment of a broad educational base in science and technology, enhanced capacity to cope with change and to pursue development goals, scientifically informed decision-making, and finally - completing the circle - expanding investment in human development with an appropriate emphasis on science and technology.

Project 2000+ is a commitment to work actively to reach the goal of scientific and technological literacy for all. *For all* means placing special emphasis on the foundation years of schooling when science and technology are, or should be, an inherent part of basic education. It also means directing attention to adult education and to the need to popularise science and technology. In both areas the focus must be on coping with the world around us, on the technology we use and above all on the need to be able to face the challenges of change which are carrying us with increasing speed into the 21st century.

Project 2000+ is a collaborative venture. The members of its Steering Committee include representatives of the World Bank, UNDP, UNICEF and UNESCO as well as of the Commonwealth Secretariat and a number of committed NGOs, notably ICSU and the

International Council of Associations for Science Education (ICASE). Our task, through phases of data collection, reflection and mobilization, is to establish an agenda for action, supporting steps that individuals, institutions, organizations and governments can take together in working to reform and revitalize science and technology education. Such an educational renewal has, of course, as an essential pre-condition that the crucial role of teachers should be recognized and that they should enjoy appropriate status, training, updating and conditions of work.

Project 2000+ is a three-phase undertaking. The first phase has provided us with a great wealth of data on scientific and technological literacy and the meanings attached to it in different settings all over the world. Reviews of projects concerned with scientific and technological literacy for development and with research on curriculum reform have been undertaken. A study of forward-looking teaching and learning strategies in science education has been conducted and reviews have been made of teacher preparation for scientific and technological literacy and of evaluation and assessment procedures. In the field of non-formal education, efforts have been directed to the assembling of information about innovative approaches. Here in France, our host country, the Cité des Sciences et de l'Industrie, La Villette, on the outskirts of Paris, demonstrates brilliantly what a dynamic institution can do to open up knowledge and understanding of science and technology to young and old from all sectors of society. I am happy to know that you are all invited to visit this remarkable institution later in the week.

The work of Phase 1 has also resulted in the compilation of bibliographies of many relevant publications and review articles and in the assembling of collections of texts and documents. With the help of UNDP it has also been possible to carry out a series of pilot studies in groups of countries in Africa, Asia and Latin America. During the past two years, valuable inputs to Phase 1 have come from a number of international and regional meetings on various aspects of science and technology education, particularly those organized by the International Council of Associations for Science Education (ICASE). We owe a particular debt of gratitude to the Commonwealth Secretariat which hosted the initial planning meeting for the development of Project 2000+ in London in April 1992 and which is generously supporting a number of participants in this Forum.

The Forum itself constitutes Phase 2 of Project 2000+ and UNESCO is happy to have had the opportunity to organize it on behalf of the other members of the Steering Committee. We see our days together as offering us a time for reflection and a launching pad for the activities which will make up Phase 3. As I said at the close of the Jomtien Conference, it is the *day after* that really counts. With our Forum, it will be the activities that our efforts actually succeed in launching that will constitute the real achievement of Project 2000+.

We have five days in which to reflect, to discuss issues and come forward with clear proposals for action. Our concern will be with ways of developing scientific and technological literacy for all and at all levels in six focus areas, each concerned with a particular aspect of the task. Following this, regional groups will be asked to put forward suggestions for action at the regional, sub-regional and national levels.

All this will prepare the way for Phase 3, a long-term co-operative effort among all the partners in the enterprise. Phase 3, the implementation phase of the project, is the most important. It will place particular emphasis on national projects initiated by governmental and non-governmental bodies and on the establishment of national task forces.

In its 1994-95 programme UNESCO itself will promote, through Project 2000+, both the development of science and technology education at the school level and their popularization throughout society. Our aim will be to move forward on a broad front, developing and strengthening links with our UN partners, with the Commonwealth Secretariat and other intergovernmental agencies as well as with bilateral donors and with non-governmental organizations.

Mesdames, Messieurs,

Je suivrai avec intérêt vos débats et espère beaucoup de leurs résultats futurs. Vos travaux reconnaissent implicitement la valeur éducative de la science et de la technologie. L'enseignement des sciences, avec ce qu'il suppose de discipline et d'éthique, a en outre une contribution essentielle à apporter au développement culturel. La culture scientifique et technologique et le sens des responsabilités civiques peuvent ensemble contribuer à faire en sorte que la science et la technologie soient judicieusement maîtrisées et dirigées et jouent à leur tour un rôle positif dans l'édification d'une culture de paix et de tolérance.

Mais, pour conclure, je voudrais souligner ce qui compte vraiment du point de vue humain dans cette grande entreprise : c'est la primauté de l'esprit, l'emprise de la capacité créatrice de chaque personne sur un milieu de plus en plus artificiel. C'est l'utilisation et l'application judicieuses des connaissances. Il s'agit de placer les découvertes, les inventions et les innovations dans leur juste cadre - celui des activités qui sont le propre de l'homme - et de proclamer la pertinence des savoirs dans ses applications pratiques. Bref, il s'agit, par la connaissance scientifique et technologique, de reconnaître la suprématie des valeurs de l'esprit et de se rendre maître de soi en restant maître du progrès et non son esclave.

Address[*]
by
Mr Georges Laforest
Chief Inspector of Education

representing

Mr François Bayrou, French Minister of Education

6 July, 1993

Director-General,
Ladies and Gentlemen,

I am greatly honoured to have been invited to take part in this inaugural meeting of the Forum most appropriately convened by UNESCO to discuss scientific and technological literacy for all.

As representative of the Ministry of Education and as Chief Inspector of Education, I feel that a particular responsibility has been conferred on me by the invitation to address all the eminent personalities and experts whom UNESCO has brought together here. In this centre of international intellectual co-operation I feel it my duty to express the concerns of all those who seek to provide young people - and adults too, in the framework of lifelong education - with a training that matches the expectations and requirements of our time.

There are many possible responses, of course, and I think UNESCO has been wise to resist the siren song of harmonization, which is all too often an attractive facade masking diminution and impoverishment. But we must also try not to turn in upon ourselves, withdrawing into traditions, values, lifestyles and behaviour patterns which for all the dignity and respect that they command can never legitimize the cultural seclusion whose effects are continually being brought home to us.

The development of science and technology in societies all over the world has undermined many firmly-held convictions and received ideas, while fostering a greater awareness of cultural reality in all its dimensions - emotional, intellectual, aesthetic, creative. Even the world of the imagination has been enriched. Science and technology are an integral part of culture, which has been able to adapt them to the needs of each society. What is new, I believe, is the importance assumed in recent decades by the scientific and technological dimension of culture. It has come to inform lifestyles, and to play a part in economic transformation and restructuring and in the broad political, intellectual and moral positions taken by our various countries, based as these are on an ever-growing number of scientific considerations.

[*] English translation

It is nonetheless true that science and technology are still perceived by public opinion in our countries as a tool which, though efficient, is sometimes disturbing; they are too often regarded as being impersonal. This means that education involves the acquisition not only of scientific and technological knowledge but also of attitudes and capacities that make it possible to understand the world around us and control it by planning and action. Much is at stake here. Pupils must be given points of reference and approaches that will enable them to find their place in today's world, to develop a critical awareness, to exercise judgment, and thus to weigh more decisively on the choices that society has to make.

Scientific and technological literacy is an essential component of general education and at the same time of effective civic education, and its cause can best be served by making science less awesome, tracing its boundaries more clearly, encouraging its intelligent popularization - and enlisting in this effort the assistance of museums, sound, film and video libraries, scientific institutions, business undertakings and the media, which all have their part to play in the educational process.

In this regard, Mr Director-General, allow me to say once again how much importance we attach to the results of the forty-third session of the International Conference on Education, held in 1992, on the theme of the contribution of education to cultural development. Just as we hoped, that conference, I think for the first time in an intergovernmental setting, emphasized the essential role of science and technology in contemporary societies without forgetting that (and I quote) 'to be liberating, scientific and technological culture has to be linked to ethical and humanistic values'.

I maintain, therefore, that scientific and technological literacy is much more than an accumulation of knowledge. Our real goal is to use educational processes to enable human beings to make science and technology their own, and in the end to bring about new attitudes by integrating knowledge with experience. In this we are perhaps not very far from the goal that the international community set itself at the World Conference at Jomtien in Thailand which expressed a determination to obtain the means to provide basic education for all. We know that illiteracy can take many shapes, and that there is a scientific and technological illiteracy from which none of our societies is free. Learning is not limited to reading, writing and arithmetic. Education cannot remain bogged down in syllabuses and techniques that take no account of scientific and technological developments, and scientific literacy cannot remain the preserve of an elite. Quite the contrary: any educational initiative geared to the self-realization of the individual and the training of the citizen must have at its very centre the acquisition of scientific scepticism and reasoned judgment, for these are the basis for critical and responsible attitudes.

In this respect we believe that the inclusion of real scientific, technical and technological literacy in education will help to overcome the simplistic dichotomy between tradition and modernity, and give our young people the methodological tools for observation, design and experimentation that they need in all our countries today. France has organized a range of courses introducing young people to science and technology that are very popular with them. But if we are to meet the needs of our times we must also do more to enhance the status of technical and vocational training.

In recent years in France, many new initiatives have sprung up around the centre for scientific discovery, initiation and training, known as the Cité des sciences et de l'industrie. School classes have visited it, and it has organized exhibitions, meetings and a large number of training courses for teachers. I might also mention the extension work of the Palais de la Découverte and of the Poitiers Futuroscope. All these initiatives, whose approach must be recognized here above all, have the common objective of making the scientific and technological environment better known and increasing awareness of the contribution made by the different skills in their relationship with scientific knowledge. It must be acknowledged that this kind of educational initiative goes well beyond the traditional frontiers of the school and even of what we call non-formal education. Scientific leisure activities themselves have become part of everyday life and are engaged in all over the world in the context of associations, clubs, museums, and other centres of social and creative activity.

So we must recognize the responsibility of each of our countries to develop an education that is modern, receptive to the contributions of science, and not limited to a single, unequivocal and dogmatic view of the world and of society. And we must also recognize the numerous restrictions that handicap the educational systems of developing countries and sorely impede their progress toward the achievement of such a system of education.

The marriage that must be achieved between education and scientific and technological literacy requires a strengthening of international co-operation, to which today's meeting and the 2000+ project to be launched by UNESCO should make a contribution.

The principal task of UNESCO is to be a laboratory of ideas, the centre of intellectual co-operation par excellence, and its recent creation of two great international commissions, one of which is discussing education for the twenty-first century, shows its attachment to this role.

'I love the past, but I long for the future... the smallest schoolchild is now aware of truths for which Archimedes would have given his life', wrote Ernest Renan in his memories of childhood and youth.

Though it is true that since the end of the last century the naive belief that scientific and technological progress would solve all humanity's problems has made few converts, we do realize that science and technology if constructively applied can bring great benefit to our daily lives. Unfortunately, there is a real danger that societies may develop where scientific and technological training could become a new dividing line between an intellectual elite and those to whom access to knowledge is barred.

One of the responsibilities of an international body such as UNESCO is to work actively to bring about an education for all that is in step with our times. In doing this it will be being true to the far-sighted, not to say prophetic, mission entrusted to it by its founders.

Plenary Addresses

Address
by
Professor Thomas R. Odhiambo

8 July, 1993

Scientific and Technological Literacy for All
A Perspective Reality

While *education* is taken to comprise 'organized and sustained communication designed to bring about learning', *literacy* implies an 'attainment of comprehension through a basic educational process'. In the world of today, a basic comprehension of scientific knowledge and technological skills has become an imperative for personal growth and national development. It is in that sense that the call made by the World Conference on Education for All (held in Jomtien, Thailand, in March 1990), in directing attention to the urgent necessity for creating a world community of scientifically and technologically literate citizens, was so apposite and timely.

To achieve such a goal would require the education, both formal and non-formal, of the entire spectrum of the population - all children, youth adults, and old folk. Indeed, scientific and technological literacy among the old people in Africa is critical - for three main reasons. First, the continent is characterized by the extended family system, in which the grand-parents assume a pivotal role in terms of family traditions, community lore, the transmission of experiential knowledge to the younger generation, and the upholding of yardsticks of excellence and societal expectations. Even though, by 1990, the old only comprised 6.0% of the total African population - in contrast to a larger proportion in the rest of the world[1] - they wield enormous influence on the eventual turnout of successive generations. Second, Africa possesses a rich diversity of languages that is found nowhere else in the world. Eschewing dialects and regional variations, Africa has more than 2,050 indigenous languages - all demonstrating a varied tapestry of poetry, song, ballads, and verbal repositories of natural history and histiography, applied sciences and technology, and philosophical musings and political economy. Thus, Africa has been always intensely literate in oral tradition, and in reading, verbal and body language, whereas the written literacy has been spotty throughout the 7,000 years of African civilization, from the Pharaonic times to the present. And, third, the comprehension of science is not absolutely tied to the understanding of mathematics 'of abstract and logically rigorous formulation'.[2] This sagacious view is shared by Enrico Cantore (1977) in his book, *Scientific Man*, where he states that 'science constitutes an essential factor of the historical development of man as a cultural being... I began to perceive that science is human not because it is produced by man, but also because it is in itself an agent fashioning man in culturally new ways'.[3] To treat science as merely a tool, a hand-maiden for development, or other variants of instrumentality, would be both short-sighted and short-handed : know-how alone would lead Africa nowhere. Africa's sense of sagacity is vital.

Science is more than a tool

Such a paradigm is well expressed in an important area of Africa's traditional knowledge base, which cannot be ignored in building a modern agricultural science and practice in the continent. This view was strongly expressed in a recent gathering of agricultural scientists and African farmers in Nigeria :[4]

> '...the traditional knowledge base grows and develops through the accumulation of new experiences and the tested results of experimentation and repeated observations. It is evolutionary in character, but it is nonetheless solidly based even though it does not necessarily grow through the analytical methodology of science. The challenge for the African agricultural scientist is to be able to understand and rationalize this vast traditional knowledge base so as to have a systemic foundation on which to build a truly African-oriented science-based agricultural practice.'

Thus, agriculture in Africa should not only be conceived as an instrumentality for earning a living. In the African context, where farming still commands the services of a very large agrarian population (from the least in Mauritius and Egypt, of 19.0% and 38.2% of the entire national population, respectively; to the normally high proportion as reflected in Senegal and Rwanda, at 80.6 and 92.8%, respectively),[5] agriculture 'must regain its capacity to provide a challenging and worthwhile way of life : an agrarian environment should not only be farmed, it should also be worked, perceived, known, and lived. In short, we are looking at farming as a way of life rather than merely a source of employment'.[4] In this milieu, the sagacious old people in the agrarian environment are able to impart a holistic sense of rural life that may well attract the youthful and the new literates to stay put and work at enjoying a fuller rural life.

The problem of the youth in Africa, that is, those who are 15 years or below, who will have attained middle-level leadership roles by the year 2020, is extremely difficult in relation to the kind of education and training they should undergo in order to fulfil those roles. The scale of the problem itself is horrendous: in 1980, these under-15 year olds constituted a massive 90.3% of the population; in 1990, it escalated to 92.8%; moreover, there are only two working-age African adults for every school-age child, in contrast to a ratio of 1:5 in the industrialized North.[1] The African population in 1990 was approximately 648 million; at that time, 240 million (or 37% of the population) constituted the labour force. The proportion of the labour force, those between 20 and 34 years old, in the year 2000 will rise to 42% of the total population. In the year 2025, the proportion of the African labour force will rise to about 45%, or 650 million out of a total expected population of 1.6 billion. During that same year, the entire labour force in the industrialized North will comprise only 636 million.[6] The current education system in Africa has achieved a great deal in the three decades since the great era of political independence, mostly in quantitative terms and in its phenomenal expansion from the secondary to the tertiary levels. But these achievements have not kept pace with the quality expected from it, nor its relevance to Africa's modern needs in a vastly competitive world which has left Africa, used to big-power protection and development aid, virtually alone and ignored. Africa needs to look afresh at the philosophical and operational bases of its education system - formal, informal and non-formal - and to deliberate on how to achieve the national and continental goals that the system is structured to attain.

Currently, the literacy rate in the continent is appalling. Adult literacy rate is a mere 45%, and even in countries with an old tradition of learning such as Senegal and Egypt, the literacy rate is only 32.1% and 44.6% respectively (1985 estimates), with mean years of schooling a paltry 0.7 and 1.7 years, respectively (1980 figures).[5] This relatively low rate, closely associated with the high density of material poverty in the continent, probably explains the comparatively low life expectancy of 51.8 years. What is most troubling, with a long-term impact level, is the paucity of scientific and technological capacity in the continent. Most countries in Africa, including Egypt, have less than 3 scientists and engineers per 1,000 population (1980-1988 figures); and there are, on average, only 7.7% of the work-force employed in the industrial sector.[5] It is clear that the various national programmes of universal primary education have achieved, or are approaching quantitative goals that have been set; but they have left a yawning gap in scientific and technological literacy at the very top - with less than 26% university graduates qualifying in science-related subjects [5] - and have shown abject failure in developing a quality content for this basic level of education. The World Bank perspective study, *Sub-Saharan Africa : From Crisis to Sustainable Development (1989)* has not minced words.[7] Quality has yet to be assured in primary education. Content is of low quality and relevance : indeed, 'tests on reading comprehension, general science, and mathematics suggest that many African students are learning very little'. Very little is spent on educational materials; on average, US$0.60 per student a year in Africa, in contrast to a basic requirement of US$5.0. And there is very little capacity to develop and fabricate low-cost teaching materials conforming to the requisite learning expectations.[7] Yet, education, particularly science and technology education, is intrinsic to modern social and economic development.

A profound change in this scenario can only manifest itself if the geopolitical leadership, the policy community, the scholarly and scientific community, and the business-industrial sector jointly and deliberately take a long-range strategic decision to break with the past, and adopt a vision of what the continent needs of its leadership by the year 2020. If the continent is to achieve a universal literacy in science and technology by that time, then it has to begin to deliberate along the lines that the Africa Leadership Forum, in its declaration formulated in *The Kampala Document*, has highlighted. The declaration begins by stating that 'people are both the means and the desired end of the benefits of development. Africa's development is principally hampered by inadequate human capabilities'.[8] It then goes on to prescribe what to do :[8]

> Illiteracy should be eliminated across the continent by year 2000.
>
> Africa should adopt national systems of meritocracy; and should therefore adopt attractive levels of incentives and compensation for professionals and public servants, so as to curb the growing brain-drain, while ensuring that African talents in Africa are used in preference to foreign experts. In this respect, Africa should establish a bank for Africa's human resources and skills.

> Science and technology should be introduced at an early age into the national education systems.

Such thinking, as illustrated by *The Kampala Document*, needs to grow into a general public debate throughout Africa. Programmatic proposals which do not comprehensively examine both the process and the objectives are unlikely to make a deep impact. For instance, the electronic media have been touted as a possible option for mass education in Africa. Yet, as K'Omudho states in a recent paper to environmental journalists in Kenya, despite the current communication explosion, 'do we effectively communicate with our people?... The huge investments by governments in the mass-media have not yet yielded real expected benefits, those of a people eager and willing to work for development'.[9]

Indeed, political will and purposeful leadership in matters of science and technology education, in furtherance of the empowerment of the entire population to engage in science-informed development, is what has distinguished Africa from its Asia co-developing countries, who are far outstripping it in this sphere. Forty years ago, the two continents had comparable living standards. How has Asia moved ahead, out-distancing Africa in the process ? The InterAction Council, in its report of a high-level meeting it convened in Cape Town, South Africa, in January 1993, has reached a most revealing conclusion.[10] Apart from implementing a green revolution-type of agriculture, which gave the South-East Asia countries food security as well as permitting them to diversify their agriculture, and apart from adopting an aggressive and highly competitive export-oriented economy which diversified into light and advanced industries, and in addition to having stable governments, these countries have a high-quality education system for all, which produced an adequately educated and skilled labour force as well as a managerial class capable of absorbing technology and investment. This modernization experience could be a model for Africa - without the continent de-banking its traditional values and experiences, as the Council states convincingly :[10]

> 'To release people's energies, Africa needs to bring back its own values, culture, identity and structures, to be confident in itself, to build on the people's sense of themselves... and to develop their capacity to think and act for themselves. *Development cannot be and should not be seen as something handed down from outside, but something emanating from within.*'

This lesson is hammered home by a South Korean political scientist very much involved in the Korean industrial resurgence, Dr Mark Suh, in his guest lecture to the Annual Research Conference of the International Centre of Insect Physiology and Ecology (ICIPE), in Nairobi, Kenya in May 1993, on 'Science and Technology Policy of Japan and Korea : From Copy to Self-Reliance', when he concluded :[11]

> 'The experiences of Japan and Korea indicate that the adaptation and utilization of Science and Technology were essential for economic as well as social advancement. This required central planning and effective management of human as well as natural resources. Education played a very important role in producing needed scientists and in adapting and advancing foreign technology. Japan and Korea internationalized their economies rapidly without losing their own culture and social structure. The examples

> of these two countries' path to development through technological advancement and independence can serve as a guide to countries now faced with the great task of determining the most appropriate means of development.'

There is no doubt that building an independent national and regional capacity in science and technology, able to create, adapt, and utilize new results from scientific research and technological development (R&D), together with the entrepreneurial and managerial capacity to transform this knowledge and know-how into technological products and social services, is a prime requirement for the rapid economic and social advancement of the continent. Foreign aid - and even multilateral assistance - can only catalyze this process : it cannot be the sole prop for this very societal responsibility of the continent itself. United States Congressman George Brown has put it succinctly in characterizing United States' aid for science and technology to developing countries :[12]

> 'In spite of such examples [of previous S&T aid to South Korea and other South-East Asian countries], efforts by the United States to promote economic development abroad have never included a comprehensive approach to science and technology. Although 'technical assistance' has been an integral part of U.S. development aid since the late 1940s, it has not served to foster an independent S&T capability in developing nations. Moreover, the S&T budget for the Agency for International Development (AID) is almost entirely devoted to research carried out by U.S. scientists on specific, and often urgent, developmental problems, not to institution-building. Of the $300 million operating budget for AID's S&T bureau in 1991, a mere $150,000 was slated for joint research with scientists from less-developed countries.'

Thus, United States policy continues to focus on supplying technology and U.S. expertise to developing countries, rather than contributing to indigenous science and technology capacity.

The published word

The public debate on science and technology for national and regional economic and social development is only starting in Africa. The decision-makers, the opinion-makers, the money-makers; the geopolitical leaders, the geoeconomic leaders, the scientific and technological leaders; the civic communities, the agrarian communities, and the workers communities - all need to be engrossed in this debate, This requires a comprehension and perspective view of science and technology of an entirely different order from what we have now.

Apart from the oral literacy in which Africa excels, it must also now embrace the written-and-reading literacy. The book, especially the science and technology book, must become a life-long friend and a fountain of knowledge and inspiration - rather than a route to success in school and college examinations. Yet the publishing world in Africa is a very poor world indeed.

There is, undoubtedly, a book famine in Africa. There are very few indigenous publishers of any significance in the continent. During the period 1985-1989, only 4 publishers in Kenya produced children's books : in 1989, a mere total of 22 titles were published in the entire country. During the same period, a total of 1,045 titles of all categories of books (textbooks, religious books, leisure books, etc.) were published : of these, only about 25% were written in Swahili and other African languages. With about 300 languages spoken in Kenya, it is certain that the great majority of the people are not literate in their own languages - which are the carriers of their culture, mores and traditions, and on which a modern science culture should be grafted.

Although there have been many attempts by international organizations and aid agencies to foster an indigenous publishing enterprise in Nigeria, Ghana, Zimbabwe, Kenya, and many other countries in Africa, a robust, confident, indigenous publishing world has still to make its entrance felt in Africa. In this situation, a concerned publishing consultant based in London, Hans Zell, has been impelled to state the obvious line of needed action :[13]

> 'The scarcity of books has meant that neither the needs of educational institutions nor of the general public can be met. Devastating and quite possibly lasting damage is being inflicted across a whole generation going through primary, secondary and university education in Africa today.'

The problem is compounded by the fact that the African famine related to science literature is even more profound than that afflicting the general book availability in the continent. In a survey published in 1990 by the recently established Council for the Promotion of Children's Science Publications in Africa (CHISCI), of science publications available for children below 14 years in bookshops in Nairobi, just over half of the titles were published in East Africa, and of those only 1.69% publications were written in African languages. The paucity of mother-tongue science publications for African children is extremely serious, as it confirms the prevalent view that science is not part of the African culture. The principal motivation of CHISCI is to reintegrate science into African culture, since the current educational system does not relate science to everyday life, to household community life, and to future livelihood. The Preface to the Survey concludes :[14]

> 'There may be many factors that could have led to this situation which could be attributed to economic situations in third world countries. However, CHISCI tends to be of the opinion that developing African countries have given this excuse for too long and this persistent shrouding of the problem has inhibited a lot of possible growth and development in many aspects including education. Science, in the context it has been put to the African society does not attract much attention... The best way to reverse this situation would be to inoculate science education at an early age.'

Prospect

If science and technology is, indeed, to form an integral component of an African culture, and to imbue it with its own genius and vitality, African educational systems - whether formal or informal, whether non-formal and on-the-job - must be able to speak, write, and think science and technology in the language of the household, as a process of reintegrating science and technology into everyday living and lifelong cultural interaction, at the same time that the international language of science and technology - in its international dialogue and trade - continues the international tradition, started in mid-nineteenth century, of communicating in English, French, and German. In this way, Africans will find a new harmony in their being at peace within themselves, while facing - at the same time - the competitive world of modern science and technology-dominated livelihood.

In the words of Sabra, in the Preface to his book on *Theories of Light*[15]: 'I came to see in the history of science the history of man's most imaginative and most rational enterprise'. Africa needs to share in this exciting and rational adventure.

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Address
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8 July, 1993

A Race Between School and Cradle

When 106 heads of state and more than 135 national delegations closed the all-important Rio Conference on Environment and Development, simultaneously, more than 800 non-governmental organizations, originating from all over the world, closed their picturesque and vibrant meetings by a concert of hope and revolt. What had motivated such a momentous gathering? Certainly not just the desire to celebrate the twentieth anniversary of the historic Conference of Stockholm, but rather a growing, roaring consciousness that the future of our planet could be threatened, and that the very survival of our species could be at stake. In spite of shocking differences between what was called the South and the North or between the East and the West, the people at large were realizing that a global consciousness was born, and that neither the leaders nor the media were reacting accordingly to this universal need for closer solidarity.

What concrete results were adopted in Rio? A revolutionary program of badly needed reforms? Of course not! The two timid conventions signed, about biodiversity and global warming, as well as an inflated document, Agenda 21, were immediately criticized by a sarcastic press, still under the influence of industrial lobbies.

We must open our eyes, our ears, our hearts! The songs and dances at the Rio Forum, were irreversible hymns of hope and of faith in humankind, and the incomplete, laborious decision of the 'Earth Summit' had made 'business as usual' impossible for ever. What is the future of the Rio spirit? A solution to the so-called economic crisis that affects only one fifth of humankind? Or to the unemployment tragedy that plagues a growing fraction of the wealthy nations? No, but now the whole world understands that in the third world unemployed are not counted in millions, but in billions, that the economic crisis is there in Africa, South America and Asia, not as an artefact, but as an endemic plague.

And thanks to Rio, nobody on earth will tolerate any more that the rich would carry on getting richer, and the poor would become even poorer. This simple message was never as clearly heralded as in Rio and now, the leaders of countries as well as the international forces, UN, UNESCO, World Bank, IMF, EBRD, UNDP, WHO and UNEP will be orchestrated by the UN Commission for Sustainable Development, to implement the Rio Conventions and Agenda 21.

It is true that, in Rio the paramount problem of population explosion was not identified as the major obstacle to our future. And the words 'sustainable development' were often brandished as symbols of an upcoming miracle. The permissive use of that expression is typical of the generalized confusion we are living in: what is the goal of life, to die rich, or to live happy? competition, or cooperation? Most of the countries have changed the name of their 'Ministry of War' to 'Ministry of Defence', without modifying anything in their structure. In the wake of face lifting, the 'Ministries of Public Instruction' that taught education are replaced by 'Ministries of Education', only dealing with instruction, and have become, under economic pressures, mere employment bureaux.

Result: millions of jobless people who know how to safely pressurize acetylene or split atoms, but have never heard of Plato. Pleasure, a selfish satisfaction, can be bought: it has replaced joy in the heart of families, under the overwhelming influence of advertising. For the same reasons, science and technology are confused in the minds of adults as well as children; science anticipation is replaced by science fiction, as in electronic games. How can young men and young women of today, wishing to play a role in the construction of the future, bear with the absurdities of our social organizations? How can they tolerate that sophisticated weapons be officially sold as if they were harvesting machines, under the pretext of creating jobs or to fight international competition! How can they accept that this program results in enriching the rich and impoverishing the poor? Or even, in some countries, like France, accept that governments at the same time produce and advertise cigarettes and tobacco, while financing a campaign against tobacco?

When words have lost their original meaning, when simultaneous political decisions are often contradictory, when information becomes universal, but unreliable, citizens lose their fixes, become temporarily intoxicated, but may wake up to violent protests. The public must be associated, as an adult, responsible partner in all difficult decisions, such as the acceptance of certain risks. All human enterprises may fail. Airplanes fall. Gas tanks explode. Nuclear plants themselves have proven not to be safe against mechanical or human failures. It may even be possible that with the sixty kilograms of enriched uranium missing in the official world inventories, unidentified terrorists or an irresponsible national leader may use the ultimate atomic weapon. In the mean time, red and green mud are dumped into the sea, ships flounder with their loads of arsenic, nerve gases, or defoliant; black tides multiply at a rhythm of almost one a week.

Scientific and technical progress have successfully fought sickness, increased the average lifespan, and improved comfort, while inevitably generating some risks. But among these risks, we must decide to refuse those that have irreversible consequences, and to minimize the others. It is urgent to introduce, in international politics, a new concept: the management of risks. This management of risks necessarily includes the evaluation of the consequences of possible accidents. Not only in the short term but also in the long term.

This management thus begins by choices that must eliminate all the risks that have a chance, even minute, to threaten the essential survival of our species.

The tragedy is that technocrats believe that the public is not able to understand problems, that we have to be talked to like ignorant children, that the technicians are the only ones who know what to do. It is not true. They don't know what they are doing.

In spite of the arrogance of technocrats, we want to know the truth when an accident occurs. We want it to be the right of all people to decide what risks they will or will not take, to protect the quality of life for future generations. However serious problems are, such as pollution, desertification, depletion of the ozone layer, warming up of the planet, transportation of dangerous materials by sea or by air, or elimination of living species, we remain practically unaware of the main cause of all the threats that menace our planet and our future, *the population explosion*. The fact that this momentous danger is never mentioned by leaders demonstrates the seriousness of the confusion I mentioned earlier and in which we now struggle.

The 30th of September last year, I gave a speech on overpopulation at the United Nations. At the end, the head of UNFPA, Doctor Nafis Sadik, gave me a computer that automatically counts the excess of births over deaths worldwide. It was only 281 days ago.

My display shows that during those nine and a half months, the population of the world increased more than 63 million... much more than the population of France! In my lifetime, the number of people tripled, from 1.5 billion to 5.5 billion. In 40 years, it will reach 10 billion!

Almost all our social evils, famines, shocking differences between rich and poor communities, desertification, decrease of biodiversity, increase in the number of hereditary taints, and even the warming up of our planet, originate in the population explosion. And that explosion is due to the fact that our new set of antinatural values -- generosity, solidarity, pride of our first medical victories on traditional evils -- had been enthusiastically applied long before we developed their logical counterpart, birth control. Our lack of synchronism between part and counterpart shows that we have been very slow to understand that our revolutionary new course, replacing harsh natural rules by our own ideals of equality, fraternity, justice, implied new duties and perils. From victims of nature, we had to become relentless protectors of nature. By refusing for ourselves the Law of the Jungle, we committed ourselves to making sure that the natural vegetal and animal kingdoms around us would still benefit from that very Law of the Jungle they cannot survive without.

We have not yet fully realized that our recent divorce from Nature, is irreversible. Our ancestors have long ago burned the bridges and there is no possible return to nature.

This implies for modern man the overwhelming burden to invent from scratch a behaviour at the same time acceptable biologically, and satisfying for his moral ambitions. If we want our precarious endeavour to succeed, we must convince all human beings to participate in our Adventure, and we must urgently find solutions to curb the population explosion that has a direct influence on the impoverishment of the less favoured communities. Otherwise, generalized resentment will beget hatred, and violence.

Our rejection of the Law of the Jungle came from our mind, not from our genes. Somehow, in the complex structure of our DNA is engraved our instinct to submit to the harsh laws and principles that have made the success and the diversity of life. The moral laws and principles that we have invented, preferred, and adopted will take a long time to conquer our genetic heritage.

We realize now that the subtle trail of our original wildcat nature has been saved, has grown and finally blossomed in the Free Market principle, the corner stone of all our modern economy. The Free Market economy is by far the most efficient system. The collapse of the communist world is mainly due to the fact that in the competition between East and West, the liberal economy of the West was much more efficient than the planned economy of the East.

However, once the East-West competition is over, a closer look leads to unanswered problems: Efficiency? What for? To boost the wealth of the rich fifth and sacrifice the poorer four fifths of humankind? Efficiency to favour the currency speculators? Efficiency to increase unemployment, to create millions of poor and homeless in the richest countries? To waste resources here that are lacking elsewhere? Efficiency to provide youngsters with only one moral ideal: get rich?

As long as the Free Market economy will not be far more severely controlled and submitted to our new set of Moral Values, it will be as cruel, as unjust, and will kill as often as the Law of the jungle we have rejected.

Today, everybody agrees that Power - political, economic or industrial power - is only justified if it serves the people. And the people, finally emerging from ignorance, but drowned by a flood of incoherent information, are struggling in an ocean of confusion. They need clarification, they need to know the facts, even bad news; they have been lied to so often, that they don't trust their leaders, their representatives nor the media. And the relationship between Science and Media is at least as confused. The two communities do not speak the same language, and a few specialized interpreters are not sufficient to reassure the public. The new responsibility of Scientists is to help change such a dangerous loch of faith, to dissipate confusion of the minds, to restore confidence in our destiny and individual pride in every human being.

Prince Albert of Monaco, a world renowned oceanographer, has been a major inspirational force in my life. He brought back from his expeditions information about marine life forms undreamed of before. But his commitment to understanding the world around us did not stop at merely answering a question to his satisfaction. He would personally ride a motorcycle from Monaco to factories in the suburbs of Paris, in the late 1800s, and talk to the workers, telling them of the importance of the ocean to the future of mankind. A prince mingling with the workers to tell them about science. What an example for both scientists and news people! What a consideration for the average citizen!

The world can no longer survive without the help and total commitment of us all. Isolationism is unacceptable. Scientists themselves are absolutely vital to translate highly technical issues to all those who will elect or choose decision-makers. The public needs help. Citizens of the world must understand the consequences of - and the alternatives for - every course of action. But just the factual knowledge is insufficient by itself. There are moral and ethical issues which cannot be ignored.

The success of the Rio revolution is in our hands. We are millions of human beings, inspired by the Rio spirit and ready to serve as apostles to improve the habitability of our dear home, the Earth.

But threatened as we are by the imminence of the disasters caused by the uncontrolled and accelerated population growth, we all agree that education has become our last recourse. Education of children, of students, of adults, with an emphasis on women and girls, education to restore the pride and the dignity of every human being, rich or poor. Do we have time, do we have the means, to successfully win this formidable challenge? Is it feasible to train children from all breeds without severely harming the precious diversity of cultures all over the world? The global generalization of food, beverages, instruction, communication, literature and art, all inspired and imposed by economic imperatives,jeopardize the generous intentions born in Rio. The trivial obstacle of the *cost* barrier is always underestimated in all official projects: today 600 million children lack adequate education, or even any kind of education! To provide one pencil to all those kids would cost 6 million dollars. To provide one very cheap schoolbook would cost 200 million dollars. And the schools themselves must be built, teachers don't exist in sufficient numbers. No electronic device can even be considered!

If the affluent communities were to decide to make the enormous sacrifices necessary, we would also be obliged to face the fact that the population explosion would in thirty years bring the number of children needing help from 600 million to 1 billion 200 million! Let us not forget what is at stake is who will win the race between schools and cradles...between an orderly human community, or chaos. We can only win this challenge if we have the courage to face such realities without flinching.

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Appendix 5

DOCUMENTS

Programme (English & French)	ED-93/CONF.016/1

Information Documents

List of Participants	ED-93/CONF.016/INFO.1
Project Document (English & French)	ED-93/CONF.016/INFO.2
List of Documents (English)	ED-93/CONF.016/INFO.3

Working Documents

Guidelines for Focus Area Groups (English & French)	ED-93/CONF.016/5
The Nature of and Need for Scientific and Technological Literacy (Summary Review, Group 1) (English & French)	ED-93/CONF.016/3.1
Scientific and Technological Literacy for Development (Summary Review, Group 2) (English & French)	ED-93/CONF.016/3.2
The Teaching and Learning Environment (Summary Review, Group 3) (English & French)	ED-93/CONF.016/3.3
Teacher Education and Leadership (Summary Review, Group 4) (English & French)	ED-93/CONF.016/3.4
Assessment and Evaluation for Scientific & Technological Literacy (Summary Review, Group 5) (English & French)	ED-93/CONF.016/3.5
Draft Declaration on Scientific and Technological Literacy for All (English & French)	ED-93/CONF.016/6
Guidelines for Developing National and Regional Activities/Projects (English & French)	ED-93/CONF.016/7
Phase 3: Regional Framework for Action (English & French)	ED-93/CONF.016/8

Reference Documents

Review: Focus Area 1	ED-93/CONF.016.REF 1.1
Review: Focus Area 2	ED-93/CONF.016.REF 1.2
Review: Focus Area 3	ED-93/CONF.016.REF 1.3
Review: Focus Area 4	ED-93/CONF.016.REF 1.4
Review: Focus Area 6	ED-93/CONF.016.REF 1.6

Background Documents

Scientific & Technological Literacy: Education for Change (Bowyer)	ED-93/CONF.016/BKD.1
WCEFA Monograph 1, Chapter 4 (Haggis)	ED-93/CONF.016/BKD.2
Bibliography: Focus Area 1	ED-93/CONF.016/BKD.3
Bibliography: Focus Area 2	ED-93/CONF.016/BKD.4
Bibliography: Focus Area 3	ED-93/CONF.016/BKD.5
Bibliography: Focus Area 5	ED-93/CONF.016/BKD.7
Bibliography: Focus Area 6	ED-93/CONF.016/BKD.8